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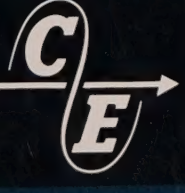
CE-7
MULTI-CHANNEL
FM COMMUNICATIONS
MONITOR



CUSHMAN
ELECTRONICS, INC.

TROUBLE	CHECK	NORMAL INDICATION	REFER TO
	Oven thermal fuse "TF"	Light remains on when oven is up to temperature	Crystal oven assembly Figure 6-.
			Crystal oven assembly, Figure 6-.

APPLIES TO INSTRUMENTS WITH
SERIAL NUMBERS ABOVE 591

CE-7
MULTI-CHANNEL
FM COMMUNICATIONS
MONITOR

CUSHMAN
ELECTRONICS, INC.
830 Stewart Dr. • Sunnyvale, CAl. 94086
Telephone Area Code 408—739-6760

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CUSHMAN ELECTRONICS, INC.

MANUAL CHANGE NOTICE

INSTRUMENT CE-7 MANUAL NO. 5601-0015-2 DATE PRINTED --

The following changes are necessary to bring your manual up to date. Changes are listed with the instrument serial numbers to which they apply. It is suggested that you enter these changes in your manual immediately.

Section 1.2.1, page 1-2, first paragraph add to the first sentence: or Model 301A Oscilloscope. Delete the third sentence and replace with the following: A similar cavity in the right-hand part of the front panel accepts a Model 303 FM Broadband Mixer, 304B, 305B, 306E, 315C RF Preselector, 313 M1 AM Monitor with FM Broadband Mixer, 314 High Sensitivity FM Broadband Mixer, or 330 Wattmeter/Duplexer Tester.

Section 1.2.2, page 1-3. Delete the first paragraph and substitute the following:

Two accessory instruments, the Model 107 FM Deviation Calibrator, and the Model 309B Remote Meters can be connected to the CE-7.

Table 4-1. Channel-Frequency Chart, page 4-10. In order for the chart to apply to the plug-ins Models 303 and 314 one line must be added as given below:

120 to 140 MHz, Plus 10 MHz, 130 to 150 MHz, ÷ 18, 7,222 to 8,333 kHz.

Table 1-2. Specifications, page 1-5, change the RF Preselector Plug-ins Model numbers to 304B, 305B, 306E and add the following RF Preselector Plug-ins:

	CHARACTERISTICS	
	Model 314 High Sensitivity Mixer	Model 315C
Frequency Coverage	20-1000 MHz	40-90 MHz
Nominal Input Impedance	50 ohms	50 ohms
Bandwidth (3 dB)		
Broad	75 kHz	65 kHz
Narrow	22 kHz	20 kHz

Model 301A Oscilloscope

Deviation Measurement Accuracy	±5% F.S. in three ranges ±1.5 kHz, ±5 kHz, ±15 kHz
External Inputs	Vertical and Horizontal
External Vertical Sensitivity	5mV, 20mV, 100mV per division ±5%.
External Frequency Response	100 kHz

Model 313 M1 AM Monitor

Frequency Coverage	20-1000 MHz
AM Modulation (Meter) Range	0-100%

Model 330 Wattmeter/Duplexer Tester

Wattmeter/Duplexer Tester	
Frequency Range	20-1000 MHz
Power Range	1-25 Watts
Accuracy	±4% Reading, +1% F.S.
Broadband Section	
Frequency Range	20-1000 MHz
Sensitivity	10mV
Input Impedance	50Ω
Bandwidth	
Broad	100 kHz
Narrow	22 kHz

Figure 4-3, p. 4-5, change the circuit reference numbers on the simplified schematic diagram and the waveform legends as follows:

From	To
R22	R38
L7	L11
C23	C31
R23	R39
Q4	Q8
R29	R46
L8	L12
C25	C35
R30	R49
R31	R47
Q5	Q10
Q4	Q8
C23	C31
C25	C35

Table 1-1, p. 1-3. Change the following Cushman Stock numbers:

Item 3	RF Cable Assembly	from 7030-0014 to 7034-0601
Item 7	Front Cover	from 2180-0033 to 7005-0034
Item 8	Equipment Manual	from 5601-0015 to 5601-0015-2

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SECTION 1
GENERAL DESCRIPTION

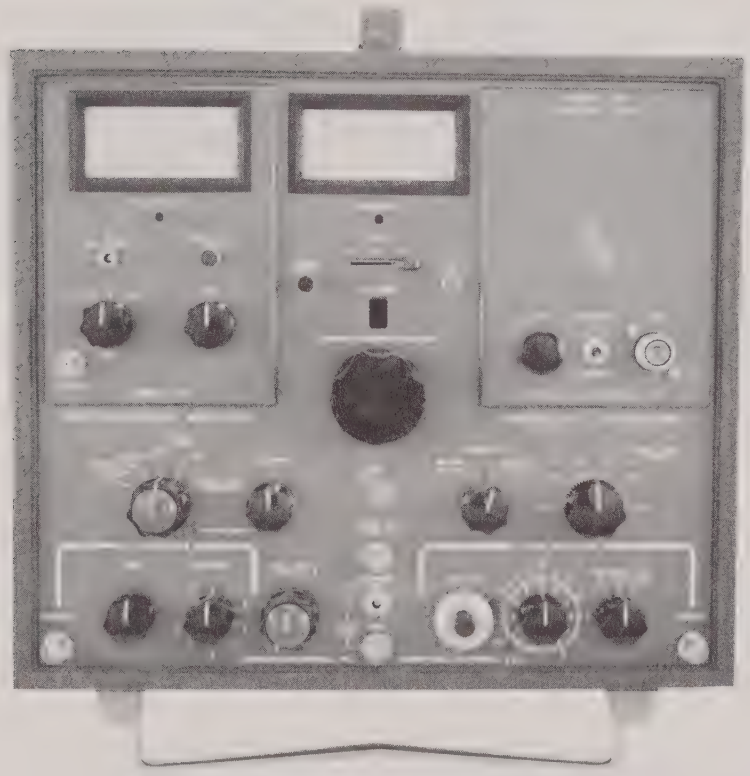

Figure 1-1. CE-7 Multi-Channel FM Communications Monitor (Equipped)

1.1 Introduction

The Model CE-7 Multi-Channel FM Communications Monitor (Figure 1-1) is designed to measure the frequency and frequency-modulation deviation of transmitters and other signal sources. The CE-7 is crystal controlled and can operate on any one of 23 frequencies between 20 MHz and 1150 MHz. Which frequencies are assigned to the 23 positions is specified by the customer. Any number of crystals between one and 23 may be selected and the operation of the instrument is not compromised if only one or two crystals are installed. The Cushman Model MCO-6 Multi-Channel Oscillator (accessory) offers an additional 23 frequencies should the need for other crystal frequencies arise.

The CE-7 can also generate FM and CW signals within the frequency limits stated above. The output level of the generated signal may be adjusted from 0.1 to 100 microvolts and provides the capability of determining the sensitivity of FM communication receivers. Signal generation of up to ten optional crystal-controlled IF

frequencies is available between 250 kHz and 13.5 MHz. The output levels of the IF signals are continuously variable.

The CE-7 must operate with either a Model 301 Oscilloscope or a Model 302 FM Deviation Meter inserted into the left-hand plug-in cavity, and a Model 303 Broadband Mixer or one of the RF plug-ins inserted into the right-hand plug-in cavity. The combination of the plug-ins is at the discretion of the customer.

1.2 Accessories

Three types of accessories are available for use with the CE-7: 1) units that plug into the monitor and obtain operating power from it; 2) external instruments; and 3) auxiliary items supplied with the monitor, but not integral parts of it.

1.2.1 Plug-In Units

A cavity accessible through an opening in the left-hand part of the monitor front panel accepts either the Model 301 Oscilloscope or the Model 302 FM Deviation Meter. One or the other of these must be used to provide FM deviation measurements. A similar cavity in the right-hand part of the front panel accepts a Model 303 Broadband Mixer or a Model 304, 305, or 306B RF Preselector.

The Model 301 Oscilloscope permits visual examination of exact modulation of the transmitter carrier. Unbalanced modulation, power-supply pulses, unusual clipping, and other problems become immediately apparent so that appropriate repairs can be made. The Model 301 has an automatic sync circuit, similar to that found in the most advanced laboratory instruments, to lock on and precisely display waveforms. The scope graticule is calibrated to show devation on any one of three ranges: ±1.5 kHz, ±5 kHz, and ±15 kHz. Switches on the front panel permit use of external vertical inputs while using the internal sweep. External signals may also be connected to the horizontal input. This permits independent use of the Model 301 of the monitoring function for routine testing, troubleshooting, displaying Lissajous patterns, etc. The Oscilloscope can also be used for receiver IF-bandwidth measurement and discriminator alignment.

The Model 302 FM Deviation Meter provides three ranges: 0 to 2.5 kHz, 0 to 6 kHz, and 0 to 25 kHz. An instantaneous-peak-indicator light flashes when the absolute peak deviation of the incoming carrier exceeds an amount preset by the operator. Operation and accuracy of the peak indicator are not affected by modulation frequency, repetition rate, or waveform. A switch permits selection and measurement of either plus or minus deviation peaks. A scope jack is provided for simultaneous meter indications and oscilloscope observations of deviation (a separate oscilloscope, not a Model 301, must be used).

NOTE

Remote display of FM deviation is possible only when the Model 302 FM Deviation Meter is used.

The Model 303 Broadband Mixer operates on all frequencies covered by the CE-7. Sensitivity is less than 10 millivolts, for close-in monitoring and in-shop measurements. A crystal filter in the broadband miser provides sharp selectivity in areas where many strong RF signals are present.

Three different RF Preselector plug-ins are available for use in the CE-7. The Model 304 operates from 25 MHz to 50 MHz, the Model 305 from 145 MHz to 175 MHz, and the Model 306B from 450 MHz to 520 MHz. The sensitivity of these preselectors is less than 20 microvolts and enables it to monitor base stations up to 50 miles away. The preselectors also have a crystal filter that permits sharp selectivity.

A telephone jack on the front panel of the 304 and 305 preselectors permits use of an external meter for reading the AGC voltage, which is indicative of the level of the incoming signal.

1.2.2 External Instruments

Three accessory instruments, the Model MCO-6 Multi-Channel Oscillator, the Model 107 FM Deviation Calibrator, and the Model 309B Remote Meters can be connected to the CE-7. The Model MCO-6 Multi-Channel Oscillator provides up to 23 additional crystal-controlled frequencies. The multi-channel oscillator is connected to the CRYSTAL OUT AUX. IN connector on the CE-7 front panel by the RF cable supplied inside the front cover of the CE-7.

The Model 107 FM Deviation Calibrator provides a means of verifying the accuracy of the FM deviation ranges of the Model 301 Oscilloscope and the Model 302 FM Deviation Meter. The calibrator must be connected to the CE-7 by a cable to the auxiliary equipment connector (CH-J4) on the left side of the CE-7, and must be used in conjunction with an external oscillator with a frequency range of 2080 to 2100 Hz.

The Model 309B Remote Meters consists of an FM DEVIATION meter and a FREQUENCY meter mounted in a cabinet that can be located at a distance of up to several hundred feet from the CE-7. The cable from the Remote Meters plugs into the accessory receptacle on the back of the CE-7. A switch near the receptacle permits selection of internal or external meters.

1.2.3 Auxiliary Items

Auxiliary items (Table 1-1) supplied with the instrument are: a 30-inch telescoping antenna; a 20-dB fixed attenuator with adapter cable, which must be used when the CE-7 is operated as a signal generator; an AC plug adapter (three prong/two prong); an RF cable assembly for interface between the CE-7 and external equipment; and a spare fuse package for replacing a defective fuse contained in the 20-dB fixed attenuator. Installation of the antenna is covered in Paragraph 3.4.6, and operation of the 20-dB fixed attenuator is described in Paragraph 3.4.2, step e.

1.3 Specifications

Table 1-2 lists the specifications for the CE-7 as well as those for the plug-in units that can be used with the CE-7.

Table 1-1. Auxiliary Items Furnished with the CE-7

ITEM	DESCRIPTION	CUSHMAN STOCK NO.	QUANTITY
1	Antenna Assembly	7040-0019	1
2	20-dB Attenuator/Adapter Cable	7040-0016	1
3	RF Cable Assembly	7030-0014	1
4	AC Adapter Plug (three prong/two prong)	2535-0001	1
5	RF Fuse, 1/32 Amp	1955-0005	2
6	Channel Frequency Chart	5500-0006	1
7	Front Cover	2180-0033	1
8	Equipment Manual, CE-7	5601-0015	1

Table 1-2. Specifications

Model CE-7 Multi-Channel FM Communications Monitor	
Frequency Deviation Measure	
Frequency Coverage	20 MHz to 1150 MHz (23 crystal-controlled channels)
Frequency Accuracy	±0.0001% (long term)
Frequency Error Ranges	±500 Hz, ±1.5 kHz, ±5.0 kHz
Frequency Error Resolution	20 Hz
RF Signal Generation - CW and FM	
Frequency Coverage (calibrated in microvolts)	20 MHz to 1150 MHz
Output Level	0-1, 0-10, 10-100 μV; ±2 dB into 50 ohms. Calibrated in μV and dB with external 20-dB fixed attenuator. (100-1000 μV without 20-dB fixed attenuator.)
Frequency Accuracy	±0.0001% (long term)
Internal FM	1.0 kHz modulation frequency. 0 to 25 kHz deviation, less than 2% distortion.
External FM Modulation	60 Hz to 20 kHz modulation frequency. 0 to 25 kHz deviation, 500 μV sensitivity.
IF Signal Generation	
Frequency Coverage	250 kHz to 13.5 MHz (10 crystal controlled channels)
Output Levels	0-1 V, 250 kHz to 900 kHz into 600 ohms; 0-0.5 V, 1.0 MHz to 13.5 MHz into 600 ohms.
Power Requirements	115 or 230 vac ±10%, 50 to 400 Hz, 175W during oven warm up, 75W max. after warm up.
Dimensions	12-1/4 in. high, 13.0 in. wide, 16.0 in. deep
Operating Temperature	+10°F (-12°C) to +130°F (+55°C)
Oven Warm-Up Time	30 minutes
Net Weight	28 pounds less plug-ins, 35 pounds with plug-ins

Table 1-2. Specifications (Continued)

Model 301 Oscilloscope Plug-in			
Deviation Measurement Accuracy	±5% full scale in three ranges: ±1.5 kHz, 5.0 kHz, 15.0 kHz		
External Inputs	Vertical and Horizontal		
External Vertical Sensitivity	300 mv for full scale		
External Frequency Response (3 dB)	30 kHz		
Model 302 Deviation Meter Plug-in			
Accuracy of Measurements	±4% full scale in three ranges: 0-2.5 kHz, 0-6 kHz, 0-25 kHz		
Model 303 Broadband Mixer Plug-in			
Frequency Coverage	20 MHz to 1150 MHz		
Sensitivity	Less than 10 mv below 512 MHz		
Input Impedance (nominal)	50 ohms		
Receiver Bandwidth (3 dB):			
Broad	80 kHz		
Narrow	13.5 kHz		
RF Preselector Plug-ins	Model 304	Model 305	Model 306B
Frequency Coverage	25-50 MHz	145-175 MHz	450-520 MHz
Nominal Input Impedance	50 ohms	50 ohms	50 ohms
Bandwidth (3 dB):			
Broad	80 kHz	80 kHz	80 kHz
Narrow	20 kHz	20 kHz	20 kHz
Sensitivity: Less than	20 microvolts	20 microvolts	20 microvolts

SECTION 2
INSTALLATION

2.1 Unpacking and Inspection

When unpacking the Model CE-7 FM Communications Monitor, inspect the packing box and the instrument for signs of possible shipping damage and see if the auxiliary items listed in Table 1-1 and shown in Figure 1-4 are present. Verify satisfactory performance as outlined in the Operating Instructions (Section 3). If the instrument is damaged, fails to operate properly, or if any of the auxiliary items are missing, file a claim with the transportation agency or, if insured separately, with the insurance company.

2.2 Environmental Requirements

2.2.1 Temperature

The CE-7 is designed to operate between +10° F and +130° F (ambient). Especially in the field, these temperatures can easily be exceeded if normal care is not taken. (For instance, the internal temperature of a closed automobile trunk may exceed 150° F during summer daylight hours.) Avoid using the instrument outside in bright sunlight on a hot day. Do not block the cabinet ventilating louvers. Exceeding the upper or lower temperature limits for extended periods may not result in noticeable damage to the instrument, but may cause poor performance or malfunctioning.

2.2.2 RF Fields

Where extremely high RF radiation fields exist (such as when the CE-7 is used near a transmitter), the telescoping antenna should be pushed down to reduce pickup. Where many high-power transmitters are in use, adjacent-channel interference may be experienced if the transmitters are operating within 90 kHz of each other. In such cases, the SELECTIVITY switch on the Model 303 Broadband Mixer should be placed in the SHARP position.

NOTE

In the SHARP position, the IF bandwidth is narrowed to the extent that absolute accuracy of the deviation display on the Oscilloscope or the meter reading on the FM Deviation meter may be slightly degraded. The SHARP position should, therefore, be used only when absolutely necessary.

2.3 Power Requirements

The CE-7 operates from a 115- or 230-volt (±10%) ac source, 50 to 400 Hz. Power consumption is 75 watts.

2.4 Warm-up Requirements

The accuracy of CE-7 measurements depends on maintaining all oscillator crystals at a constant temperature, so that any one of them may be selected as the "master-oscillator" crystal at any time. A thermostatically controlled oven which requires a 30-minute warm-up period houses up to 23 crystals. Oven operation is independent of the VOLUME POWER OFF control; it is recommended that the instrument be installed such that it can be kept plugged into its power source and be ready to make precise measurements within seconds after power is applied to measuring and generating circuits.

NOTE

If the instrument has been stored at a temperature below +32° F, additional warm-up time may be required.

2.5 Preparation for Reshipment

No special instructions are required for packing the Model CE-7 Multi-Channel FM Communications Monitor, if it becomes necessary to return the instrument to the factory for service or repair, however, it is recommended that the shipping box and foam packaging be kept for this purpose.

SECTION 3

OPERATING INSTRUCTIONS

3.1 Introduction

Section 3 contains instructions for operating the CE-7 Multi-Channel FM Communications Monitor, and includes a functional description of all controls and indicators. Refer to Table 3-1.

The CE-7 can be operated on one of three modes, depending on the position of the black/red concentric control knob located on the left side of the front panel directly below the MULTI-CHANNEL MONITOR.

NOTE

For the purpose of discussion the 5-position, outer black knob will be referred to as the "function switch" throughout this manual.

In the FREQ.-DEV. MEASURE position of the function switch the CE-7 operates as a receiver-monitor. The incoming signal is applied through the ANT. connector on the Broadband Mixer or Preselector, either from an antenna or other signal source. The received signal frequency is measured by selecting the assigned carrier frequency of the transmitter by means of the CARRIER FREQUENCY SELECTOR switch and reading the frequency error on the FREQUENCY meter. Simultaneous with the frequency error, modulation deviation is indicated by the FM DEVIATION meter on the Model 302 FM Deviation Meter or on the screen of the Model 301 Oscilloscope, whichever is used. A built-in speaker makes the modulation on the incoming carrier audible.

In the CAL./CW or FM position of the function switch the CE-7 operates as a signal generator. The desired signal frequency is selected by means of the CARRIER FREQUENCY SELECTOR switch. The generated signal (CW or FM) is available at the SIGNAL GENERATOR OUTPUT connector. The attenuator provides calibrated outputs of 0 to 1, 0 to 10, or 0 to 100 microvolts when the 20-dB fixed attenuator is used. When FM has been selected (instead of CW) the modulation can be varied from zero to 25 kHz deviation. The FM DEVIATION meter or the oscilloscope can also be used to read the modulation of this generated signal. An internally-generated, 1-kHz modulating frequency or an external audio source can be used.

In the I. F. position of the function switch the CE-7 operates as a generator of frequencies that are usually found as IF frequencies in communications receivers. The desired frequency is selected by means of the I. F. GENERATOR SELECTOR switch. The generated IF frequency is available at the I. F. GENERATOR OUTPUT connector and its level is varied by means of the I. F. GENERATOR LEVEL control. When setting the SELECTOR switch, refer to the Channel Frequency Chart located inside the front cover of the CE-7 for the position associated with the desired IF frequency. See Paragraph 3.4.5 for installation and removal of IF Oscillators.

3.2 Controls and Indicators

The Model CE-7 controls and indicators are listed in Table 3-1. For all other equipment or accessories, refer to the applicable equipment manuals.

3.3 Starting Procedure

a. Plug the power cord into an ac-power outlet (115 volts, 50 to 400 Hz) and energize the set by means of the power switch on the VOLUME POWER OFF control.

NOTE

The Crystal Oven Assembly is energized as soon as the CE-7 power cord is plugged in.

b. Ascertain that the channel pilot light is on.

c. Allow the CE-7 to warm up for approximately 30 minutes. The OVEN ON light will begin to cycle on and off. If the CE-7 has been stored at temperatures below 32°F additional warm-up time may be required.

Table 3-1. Controls and Indicators

NAME	REF DESIG.	FUNCTION
I. F. GENERATOR		
OUTPUT	J1	A BNC-type female connector which provides access for the output of IF frequencies in the range of from 250 kHz to 13.5 MHz.
LEVEL	R2	Permits adjustment of the I. F. GENERATOR OUTPUT.
SELECTOR	S4	Permits selection of up to ten different frequencies in the range of from 250 kHz to 13.5 MHz.
Function Switch	S1	Outer black control knob permits selection of I. F. HARM. AMP. TUNING, CAL./CW, FM, or FREQ.-DEV. MEASURE.
		Inner red control knob permits zeroing of the FREQUENCY meter.
I.F.		In this position, the CE-7 is an IF-signal generator and provides the capability of generating up to ten frequencies in the range of from 250 kHz to 13.5 MHz.
HARM. AMP. TUNING		In this position the harmonic amplifier can be tuned for maximum signal output of the selected carrier frequency with the HARM. AMP. TUNING control.
CAL.	R1	In this position the inner red control knob is used to zero the FREQUENCY meter. The FREQUENCY meter range is automatically in ±0.5 kHz regardless of the position of the ±kHz (FREQUENCY lever).
CW		In this position, the CE-7 generates a CW signal.
FM		In this position, the CE-7 generates an FM signal. The frequency of the generated signal is shown on the FREQUENCY meter, and FM deviation is indicated by the Oscilloscope or FM Deviation Meter plug-in.
FREQ.-DEV. MEASURE		In this position, the CE-7 is a receiver-monitor and both carrier frequency and FM deviation of an incoming signal can be measured.
VOLUME POWER OFF	S5, R3	In the POWER OFF position, no AC power is being supplied to any circuits except the Crystal Oven Assembly. In any position other than OFF, AC power is supplied to all circuits of the CE-7. The VOLUME potentiometer provides a means for adjusting the audio-amplifier output.

Table 3-1. Controls and Indicators (Continued)

NAME	REF DESIG.	FUNCTION
DEV. ADJ. FM CAL.	R4 R5	Black/red concentric controls used when the function switch is in the FM position. The outer black control knob, DEV.ADJ., permits adjustment of the amount of deviation of the FM signal generator output and the level of the internally generated 1-kHz output. The inner red control knob, FM CAL., permits adjustment of the generated-FM center frequency. The FREQUENCY meter is automatically in the ±5.0 kHz range when the function switch is in FM.
FM MOD. INT.-EXT. 1 kHz OUT	S6, J2	With the function switch in the FM position, the FM MOD. switch permits selection of the modulation source. In EXT., an external modulation signal can be applied through the BNC connector just below the switch. In INT., an external 1-kHz source is turned on. This same 1-kHz signal is available at the BNC connector for external use.
CRYSTAL OUT AUX. IN	J4	A BNC-type female connector which provides the capability to monitor the crystal frequency of the selected channel. (The output level should be greater than 600 mv unterminated.) It also provides a connection point for 23 additional crystal-controlled frequencies from the Model MCO-6 Multi-Channel Oscillator.
FREQUENCY BELOW 40 MHz - ABOVE 40 MHz	S3	Permits reversing the polarity of the FREQUENCY meter so any carrier-frequency error measured will always be indicated in the correct direction. This is also applicable to the Model 301 Oscilloscope. (When operating BELOW 40 MHz the CE-7 local-oscillator frequency is higher than the frequency to be monitored.)
HARM. AMP. TUNING	C5	Permits tuning of the harmonic amplifiers for the selected RF channel. Tuning is indicated on the FREQUENCY meter. Refer to the Channel Frequency Chart for approximate settings associated with each channel listed.
SIGNAL GENERATOR		
LEVEL SET	R7	When set to the number listed with the desired carrier frequency on the Channel Frequency Chart, the signal-generator output level will be as indicated by the MICROVOLTS (0.1 to 1.0 microvolts) and X1, X10, X100 (Multiplier) settings. The 20-dB fixed attenuator must be used.
MICROVOLTS (Attenuator Vernier)	R8, R9	
X1, X10, X100 (Multiplier)	S7	
OUTPUT	J3	A BNC-type female connector which provides signal generation output for the frequency selected.

Table 3-1. Controls and Indicators (Continued)

NAME	REF DESIG.	FUNCTION
CARRIER FREQUENCY SELECTOR	S1 (CH)	Provides selection of any one of 23 RF channels for frequency error and FM deviation measurement or signal generation. Channel numbers 1 through 23 are associated with specific carrier frequencies as recorded on the Channel Frequency Chart. The AUX. position permits connection of additional crystals to the CRYSTAL OUT AUX. IN connector on the front panel.
SIGNAL LEVEL	DS1	In FREQ.-DEV. MEASURE position, this lamp will light when a received signal is strong enough for reliable frequency measurements. In CAL./CW or FM position, the lamp will always be on.
CHANNEL	DS1 (A1)	Indicates that the CE-7 is on.
OVEN ON	DS2	Indicates that there is power to the Crystal Oven Assembly. The oven will normally be on for approximately 30 seconds and off for approximately 90 seconds after the operating temperature of 76.2°C has been reached.
±kHz (FREQUENCY lever)	S2	Permits selection of the three directly calibrated, full scale FREQUENCY meter ranges of ±0.5 kHz, ±1.5 kHz, or ±5.0 kHz.
FREQUENCY (meter)	M1	Provides indication of received-signal frequency error. This error, and whether it is above or below the selected frequency, is directly indicated in ±kHz. The meter is also used to indicate the center frequency of the signal-generator output. The meter is automatically in the ±5.0 kHz position when the function switch is in FM.
METERS INT.-EXT. (rear panel)	J1 (RP) S1 (RP)	The 8-pin connector permits use of the Model 309B Remote Meters when the associated slide switch is in the EXT. position.
FUSES (rear panel)	F2 (RP) F1 (RP)	Main AC-power to fuse (1.0 amp slo-blo). Provides protection (2/10 amp slo-blo) to the Model 301 Oscilloscope.
Auxiliary Equipment Connector (left side-lower left corner of instrument)	J4 (RP)	A 12-pin connector for the Model 107 FM Deviation Calibrator. NOTE The Model 107 FM Deviation Calibrator must be used in conjunction with an external oscillator with the capabilities of 2080 to 2100 Hz.

3.4 Operating Procedures

3.4.1 Frequency and Deviation Measurement

It is assumed that the CE-7 is equipped with a Model 303 Broadband Mixer and either the Model 301 Oscilloscope or the Model 302 FM Deviation Meter. For measurement of frequency and deviation with one of the RF Preselectors instead of the Model 303, the same procedure is followed except that the preselector frequency dial must be set to the frequency selected with the CARRIER FREQUENCY SELECTOR.

a. Connect the telescoping antenna, an external antenna, or other signal source to the ANT. connector on the Broadband Mixer or Preselector. If the telescoping antenna is used, extend it to its full length for measurements of signals below 30 MHz to approximately 18 inches for VHF measurements; use minimum length for UHF measurements.

b. Select the desired carrier frequency with the CARRIER FREQUENCY SELECTOR.

c. Place the function switch in the HARM. AMP. TUNING position and adjust the HARM. AMP. TUNING control for a maximum reading on the FREQUENCY meter. The HARM. AMP. TUNING control should indicate the appropriate number recorded on the Channel Frequency Chart.

d. Turn the function switch to CAL./ CW. The SIGNAL LEVEL lamp should light.

e. Adjust the inner red knob (concentric with the function switch) for a zero (mid-scale) reading on the FREQUENCY meter.

f. If the Model 301 Oscilloscope is being used, set the toggle switches for horizontal and vertical inputs to the INT. positions and adjust the VERT. POS. control so that the trace is on the zero reference line while the deviation range switch is in the ±1.5 position. Adjust the scope INTENSITY, FOCUS, and ASTIGMATISM controls for a sharp trace on the screen.

g. Set the function switch to the FREQ.-DEV. MEASURE position.

CAUTION

The signal level applied to the ANT. connector should not exceed 5 milliwatts or the plug-in may be damaged.

h. Key the transmitter or other signal source to be monitored. The SIGNAL LEVEL lamp should come on. If it does not, increase the signal level at the ANT. connector. Normally, if the telescoping antenna is used, measurements can be made easily when the CE-7 is between 25 to 50 feet from the radiating antenna. When a plug-in preselector is being used, measurements can be made at distances up to 50 miles from the transmitter if an adequate external antenna is used.

i. The difference between the measured signal frequency and the CE-7 carrier frequency is indicated on the FREQUENCY meter according to the position of the ±kHz (FREQUENCY lever).

j. Modulate the transmitter or other signal source to be monitored when FM deviation is to be measured. Select the appropriate full-scale sensitivity with the range switch (kHz) on the deviation plug-in being used. When the oscilloscope is used, positive modulation peaks appear above and negative peaks below the zero reference line; the FM deviation meter will indicate either positive or negative peaks depending on the setting of the FM DEV. PEAKS switch. If the DEVIATION PEAKS indicator on the FM Deviation Meter has been calibrated (see Model 302 FM Deviation Meter equipment manual) all modulation peaks which exceed a preset level will cause this indicator to light. The accuracy of deviation measurement may be affected by the position of the SELECTIVITY switch on the Broadband Mixer or Preselector. (Refer to the applicable plug-in operating instructions.)

3.4.2 CW-Signal Generation

a. Set the CARRIER FREQUENCY SELECTOR to the desired carrier frequency.

b. Place the function switch in the HARM. AMP. TUNING position and adjust the HARM. AMP. TUNING control for a maximum reading on the FREQUENCY meter. The HARM. AMP. TUNING control should indicate approximately the appropriate number recorded on the Channel Frequency Chart.

c. Place the function switch in the CW position and zero (mid-scale) the FREQUENCY meter with the CAL. control (inner red knob).

d. Adjust the LEVEL SET control to the SIG. GEN. SET LEVEL number listed on the Channel Frequency Chart for the desired carrier frequency.

CAUTION

When the CE-7 is directly connected (via the 20-dB fixed attenuator) to a transceiver, its transmitter should NEVER be keyed. Any input in excess of 2 watts will blow the fuse in the 20-dB fixed attenuator and may damage the instrument.

e. A coaxial cable with a 20-dB fixed attenuator is stored inside the instrument's front cover; connect the cable to the front-panel connector marked SIGNAL GENERATOR OUTPUT. The signal-generator attenuator settings are only valid if the 20-dB fixed attenuator is used.

f. The desired frequency is now being generated. The output level can be adjusted by means of the X1, X10, X100 (Multiplier) and MICROVOLTS (Attenuator Vernier) controls.

3.4.3 FM-Signal Generation

a. Perform steps 3.4.2a through f. These steps calibrate the CE-7 in preparation for FM signal generation.

b. Place the function switch in the FM position.

c. Set the DEV. ADJ. control fully counterclockwise.

d. Zero (mid-scale) the FREQUENCY meter with the FM CAL. control (inner red knob).

e. Set the FM MOD. switch to INT. or EXT. as desired. In the INT. position the modulating frequency will be 1 kHz; external modulation frequencies can be applied through the BNC connector when the switch is in the EXT. position. When the FM MOD. switch is in the INT. position, the 1 kHz signal is available at the 1 kHz OUT connector. The level of the 1 kHz OUT is adjusted with the DEV. ADJ. control, which is also used to set the level of external modulation applied to the EXT. connector.

NOTE

The FREQUENCY meter will now show the modulator center frequency and the FM Deviation Meter or Oscilloscope will now indicate the amount of deviation of the generated modulation. The FM CAL. control varies the center frequency of the FM signal and permits testing of receivers for alignment and maximum sensitivity. The FREQUENCY meter is automatically in the ±5.0 kHz range when the function switch is in the FM position, and it cannot be changed by the ±kHz (FREQUENCY lever).

3.4.4 IF-Signal Generation

a. Place the function switch in the I. F. position.

NOTE

On earlier models of the CE-7 the IF position ON switch is part of the I. F. GENERATOR LEVEL control. If the instrument has an I. F. position on the function switch, place the switch in that position rather than in FREQ.-DEV. MEASURE.

b. Set the SELECTOR switch to the desired IF frequency listed on the Channel Frequency Chart.

c. The IF signal output is available at the I. F. GENERATOR OUTPUT connector and the output level may be adjusted by the I. F. GENERATOR LEVEL control.

3.4.5 Installation and Removal of IF-Oscillators

The IF-Oscillator boards 0104 and 0105 are pin mounted on the Multi-Oscillator board 0103 inside the left-hand side of the CE-7. See Figure 3-1. When an IF-crystal frequency is added, deleted, or changed to a different position, the following procedure for removing and installing an IF Oscillator board should be used:

a. Turn the VOLUME POWER OFF control to the OFF position.

b. Remove the left-hand L-shaped cover (six screws).

c. Carefully remove the IF-Oscillator board from the Multi-Oscillator board, When inserting an IF-Oscillator board ensure that the guide pins on the Multi-Oscillator board are aligned with the sleeves on the IF-Oscillator board.

d. Log any additions, deletions, or changes in crystal frequency position on the Channel Frequency Chart.

e. Replace the L-shaped cover and secure with the six screws.

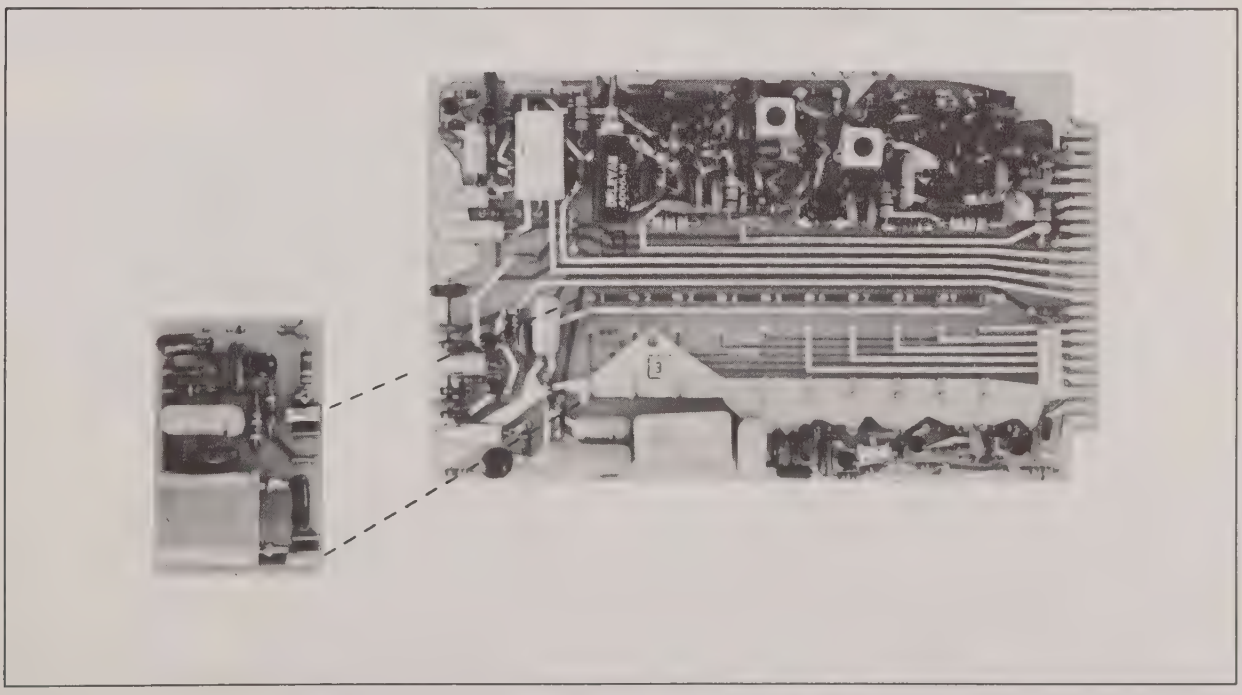

Figure 3-1. Installation-Removal, IF-Oscillator Boards

3.4.6 Antenna Installation

Remove the telescoping antenna from the front cover of the CE-7. Insert the telescoping antenna into the ANT. connector on the RF plug-in used and turn the connector collet until finger-tight.

CAUTION

When removing the telescoping antenna from the ANT. connector DO NOT rotate the antenna before loosening the connector, otherwise damage will result.

3.4.7 Installation and Removal of Crystals

The following procedure should be followed when field installation or removal of frequency-determining crystals, inside the Crystal Oven Assembly, becomes necessary.

NOTE

The CE-7 must be disconnected from the AC outlet whenever the insulated Crystal Oven Assembly cover is removed. The oven is energized whenever power is present.

a. Place the CE-7 on its rear panel with the bottom cover toward the operator.

b. Remove the six bottom-cover screws.

c. Remove the four screws securing the insulated Crystal Oven Assembly cover. DO NOT try to remove the center screw.

d. Install the new crystal(s) in the desired position.

NOTE

Be careful to install the proper frequency crystal for the desired operating frequency. The correlation between crystal frequency and operating frequency is shown on the box in which the crystal is packed.

e. RECORD THE POSITION IN WHICH EACH CRYSTAL IS INSTALLED ON THE CHANNEL FREQUENCY CHART.

f. Replace the insulated Crystal Oven Assembly cover with the four screws.

g. After the insulated Crystal Oven Assembly cover has been replaced, allow the oven to stabilize its temperature for approximately 30 minutes.

h. Calibrate the crystal oscillator according to the instructions contained in Paragraph 5.4.2 and Table 5-3.

i. Replace the bottom cover with the six screws.

3.5 Turn-Off Procedure

To turn the CE-7 off, simply place the VOLUME POWER OFF control in the OFF position. If possible leave the AC plug connected so that the Crystal Oven Assembly stays on. Unless the crystals in the oven are kept at a constant temperature, frequencies will vary and precise measurements cannot be made without a minimum warm-up period of 30 minutes.

SECTION 4
CIRCUIT DESCRIPTION

4.1 Introduction

The circuits of the Model CE-7 Multi-Channel FM Communications Monitor are on five printed circuit boards: the Second IF and Discriminator board (0054), the Power Supply board (0100), the Frequency Error Meter board (0101), the Harmonic Generator board (0102), and the Multi-Oscillator board (0103). Figure 4-1 is the functional block diagram of the CE-7. The 115-vac-supply fuse RP-F2, is on the inside of the rear panel.

The CE-7 is basically a multi-channel superheterodyne receiver and a signal generator. In the FREQ.-DEV. MEASURE mode of operation the RF signal, the frequency and frequency deviation of which are to be measured is applied through the ANT. connector of the RF plug-in that is being used (a Broadband Mixer or one of the three Preselectors). The RF signal is mixed in the RF plug-in with the local-oscillator signal from the Harmonic Generator board in the CE-7.

The local oscillator signal has a frequency that results from mixing the output of a selected crystal oscillator (associated with the selected channel) with the output of a 10-MHz crystal oscillator. When an RF signal must be measured for carrier-frequency accuracy, the frequency that has been assigned to the transmitter of the RF signal is the same frequency that is selected on the CE-7. Thus, the CE-7 can only monitor a signal for which it has a crystal of appropriate frequency.

The incoming signal is mixed with the internally generated "standard" or local-oscillator signal. If the transmitter of the incoming signal is on-frequency, the result of this mixing will be an IF of exactly 10-MHz. If the frequency of the incoming signal is not correct, the IF signal will be 10 MHz plus or minus the frequency error.

The 10-MHz signal (± frequency error) is fed to the Second IF and Discriminator board where it is amplified and mixed with a 9.9-MHz signal from the Multi-Oscillator board to form a second IF and 100 kHz (± frequency error). This second-IF signal is amplified and applied to the frequency-error detector.

A squelch detector in the Broadband Mixer or Preselector rectifies the 10-MHz signal. The resulting dc voltage is amplified and fed to the signal-level detector in the CE-7. If the 10-MHz signal exceeds a preset level, the SIGNAL LEVEL lamp lights to indicate that accurate measurements can be made and the frequency-error detector is energized. The frequency-error detector is adjusted to give a zero indication on the FREQUENCY meter when the second IF signal is exactly 100 kHz. If the frequency of the monitored signal is above or below the frequency selected with the CARRIER FREQUENCY SELECTOR, the input to the frequency-error detector will be exactly the same amount above or below 100 kHz. The detector output will cause the FREQUENCY meter to deflect toward the plus (+) or minus (-) side, indicating the direction and amount of frequency error.

If the monitored signal is frequency modulated, the modulation will be present in the output of the frequency-error detector. This output is demodulated and a signal representing the modulation is amplified and fed to either the Model 302 FM Deviation Meter or the Model 301 Oscilloscope. If the Model 302 is used, its FM deviation meter will indicate the peak deviation of the FM signal. On the Model 301 Oscilloscope, the amount of deviation and frequency-error will be shown on the CRT.

The CE-7 can be used as a CW- or FM-signal generator but its range is limited to the frequencies for which crystals are installed (if the Model MCO-6 Oven-Oscillator is used, the range is extended to include the auxiliary crystals).

A signal generated with the CE-7 is derived from the same sources as the LO. signal with which an incoming signal is mixed to form the first IF and to determine frequency error. Because there is always a 10-MHz difference between the selected frequency and the LO. signal, this 10-MHz difference must be removed before the LO. signal can be used as a signal-generator output of the selected frequency. The removal of this difference is accomplished by mixing a 10-MHz signal originating on the Multi-Oscillator board with the LO. signal in the Signal Generator Mixer. For both CW and FM signals, this 10-MHz signal is passed through a step attenuator before being fed through the Signal Generator Mixer. This attenuator permits control of the signal-generator output level, but the calibration is only valid if the 20-dB fixed attenuator provided with the CE-7 is connected to the output connector.

An FM signal can be modulated by an internally generated 1-kHz signal or a modulating signal from an external source can be applied at the FM MOD./1 kHz OUT connector.

The amount of peak FM deviation is adjustable by the DEV. ADJ. control and is read on the FM Deviation Meter or Oscilloscope in the same manner as when monitoring an incoming RF signal. When the FM MOD. toggle switch is in the INT. position, the 1-kHz signal is available at the FM MOD./1 kHz OUT connector for external use and the output level is adjustable with the DEV. ADJ. control.

The CE-7 can be used as a generator of frequencies that are usually encountered in IF stages of commercial receivers if crystal-controlled IF oscillators are obtained for installation on the Multi-Oscillator board. Up to ten of these plug-in units can be used at one time and crystals with any frequency between 250 kHz and 13.5 MHz can be made available. The desired frequency is selected and the signal level is adjusted with front-panel controls. The output is available at the I. F. GENERATOR OUTPUT cornector.

In the following paragraphs reference will be made to two groups of figures. The first group consists of figures numbered 4-1 through 4-7 which are interspersed with the text; the second group consists of schematics number 6-1 through 6-9 which are part of Section 6. Each schematic in Section 6 is placed adjacent or in close proximity to associated parts lists and parts pictorials.

4.2 Second IF and Discriminator Board

Figure 4-2 is a block diagram and Figure 6-1 is the schematic diagram of the Second IF and Discriminator board. In the FREQ.-DEV. MEASURE mode the first IF of 10 MHz from the Broadband Mixer or Preselector to the Second IF and Discriminator board is amplified by IC1 and mixed in IC2 with a 9.9-MHz second local oscillator signal from the Multi-Oscillator board buffered by Q1. The resulting 100 kHz second-IF signal is filtered and then amplified by Q2 and Q3. The square wave out of Q3 is differentiated by R20 and C22 and sent to pulse shaping network CR1 and CR2. Only the positive alternations are used to trigger Q4, the normally-off side of the one-shot multivibrator; Q4 turns on and Q5 turns off. The multivibrator remains in this state for 5 microseconds before reverting to its normal state. This 5 microsecond period is constant regardless of the frequency with which the multivibrator is triggered and is calibrated by adjusting the CAL. control. If the incoming signal is on frequency, and the second-IF signal is, therefore, exactly 100 kHz and if there is no modulation on the second-IF signal, the time between triggers is 10 microseconds and square waves result at the collectors of Q4 and Q5. Refer to Figure 4-3. When there is an error or the second-IF signal is modulated, then the time between triggers will be longer or shorter than 10 microseconds. When the time between triggers is longer than 10 microseconds, Q5 is turned ON for a longer period than it is turned OFF. When the time is less than 10 microseconds, Q5 will be OFF for a

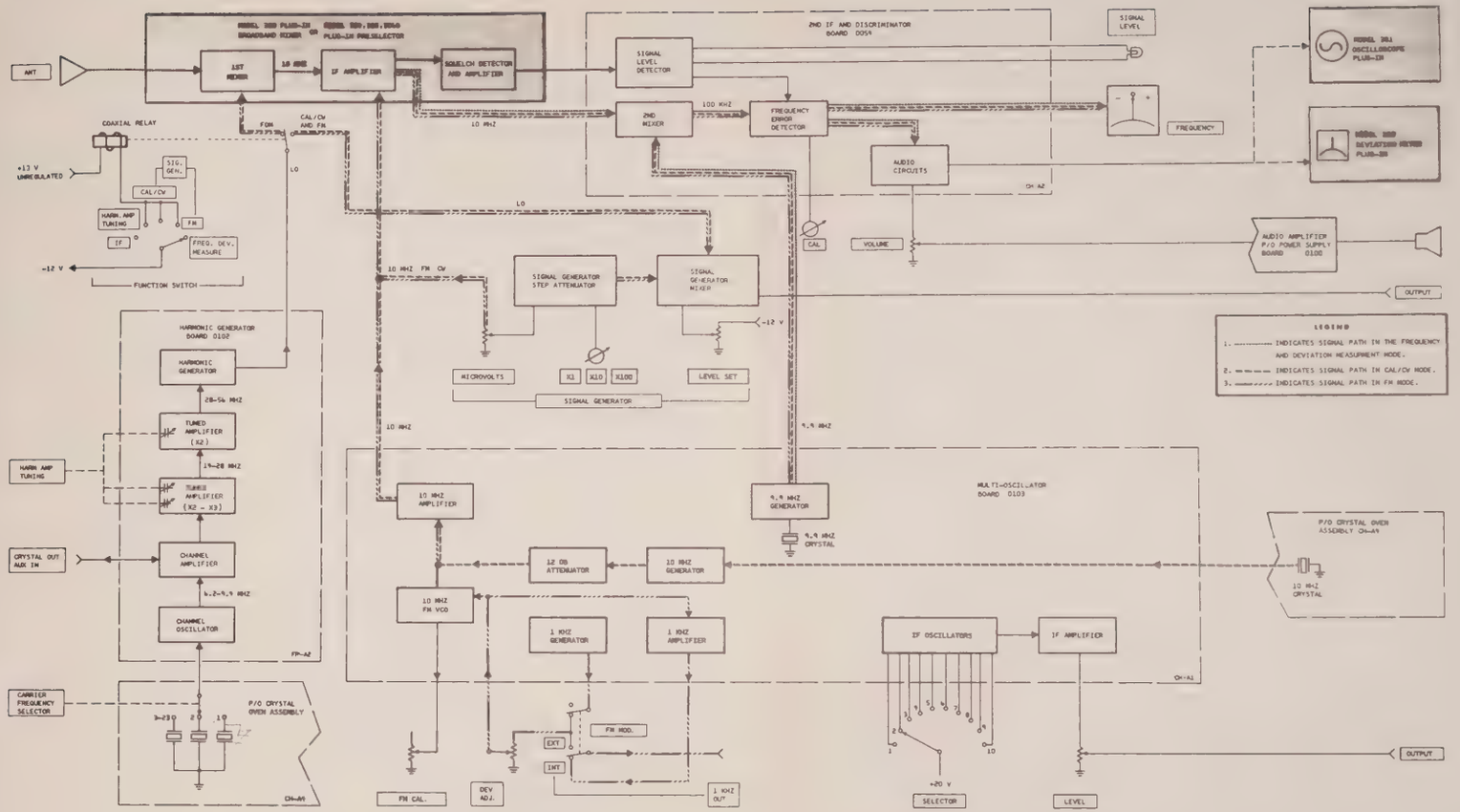

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Figure 4-1. CE-7, Block Diagram

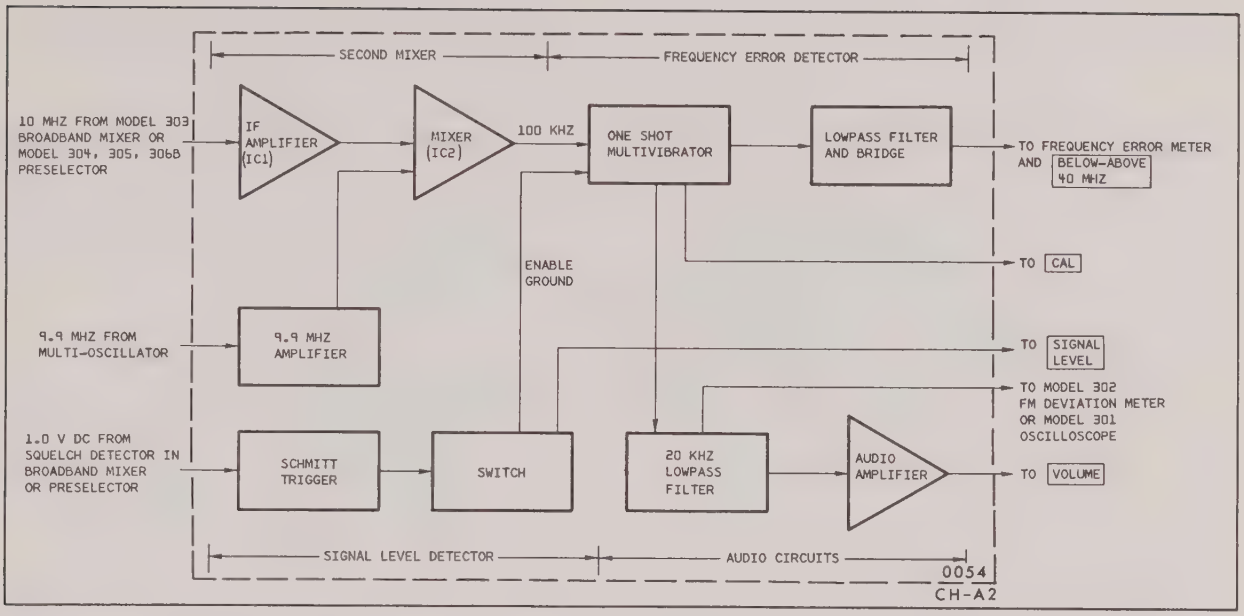


Figure 4-2. Second IF and Discriminator Board, Block Diagram

longer period than it is on. The resulting rectangular waveshape at the collector of Q4 will be high for a time longer or shorter than 10 microseconds and the waveshape at Q5 will be correspondingly low. These push-pull signals are filtered and turned into unbalanced dc signals at the bridge output. The FREQUENCY meter is then driven negative or positive depending on the magnitude and the direction of the error.

The output of the multivibrator is taken from the collector of Q5 and is fed to the base of emitter follower Q9. Q9 drives the 20-kHz lowpass filter which removes the 100 kHz content.

The output of the 20-kHz lowpass filter consists of the average dc value of the square wave at the collector of Q5 with no modulation. This value is 3.2 vdc with the FREQUENCY meter at zero. See Figure 4-4, detail A. During the positive cycle of modulation, the 5-microsecond pulse at the collector of Q5 occurs at shorter intervals. Therefore, the voltage at the output of the 20-kHz lowpass filter

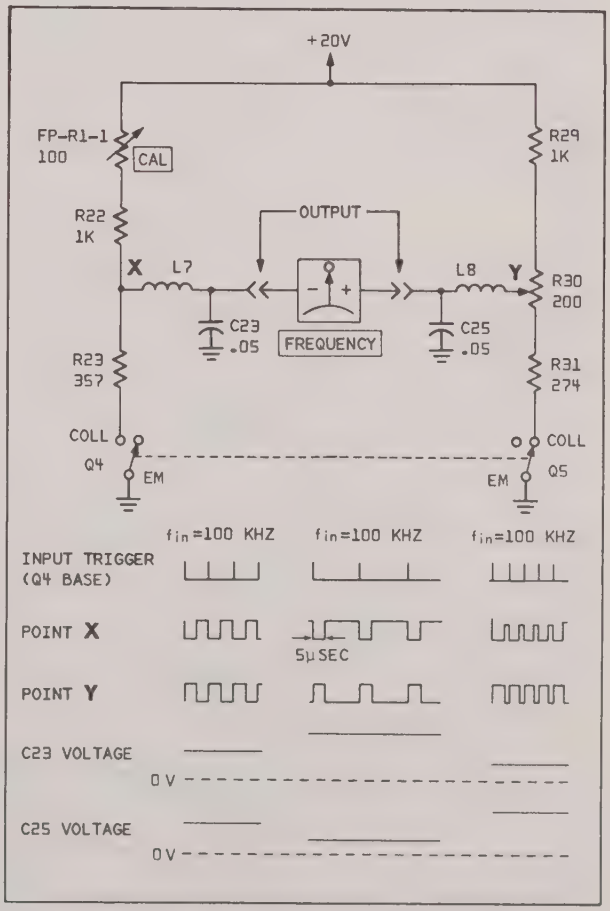


Figure 4-3. Frequency-Meter Bridge, Simplified Schematic Diagram and Waveforms

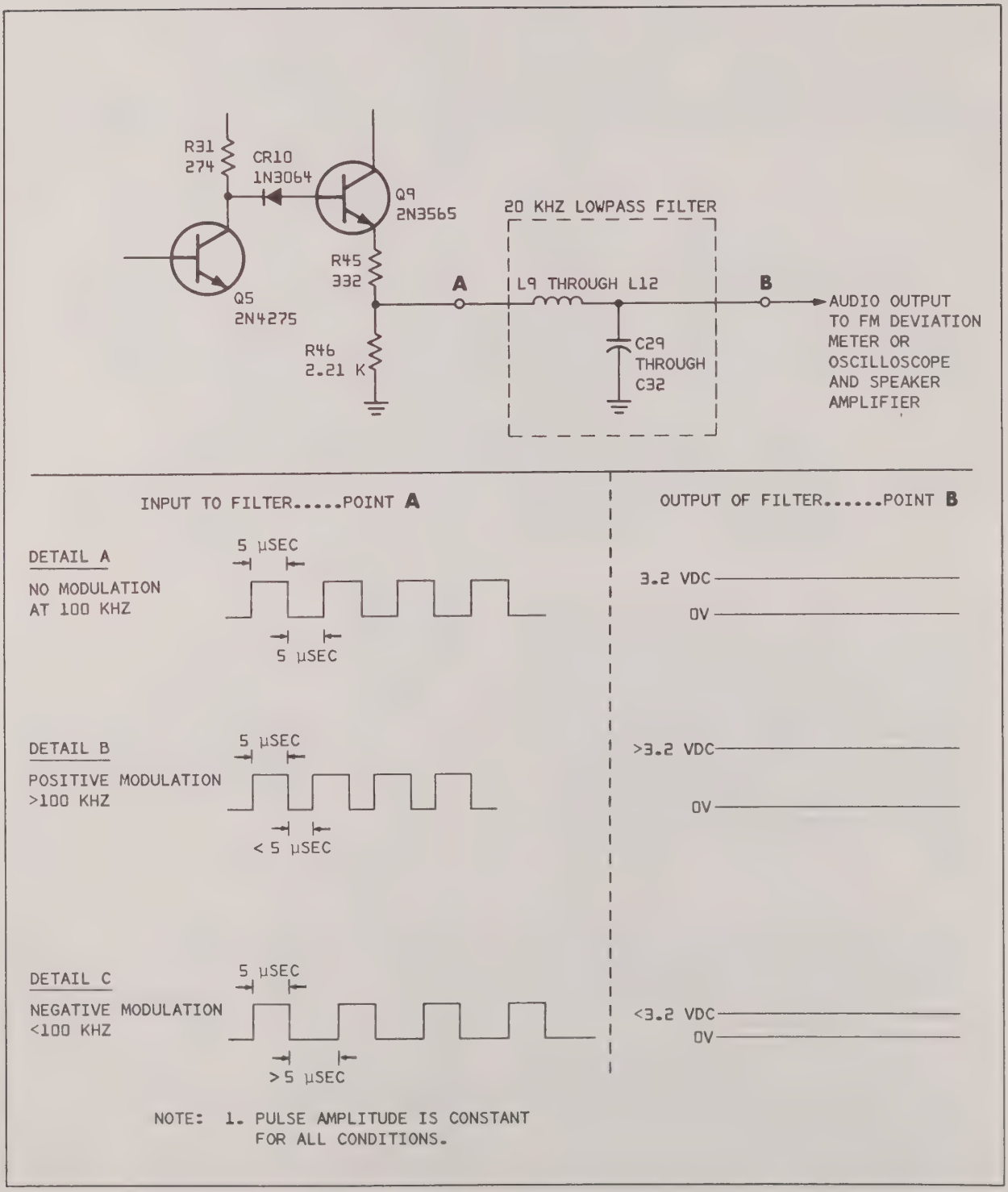


Figure 4-4. Audio-Output Filter, Simplified Schematic Diagram and Waveforms

will be of a higher value. See Figure 4-4, detail B. During the negative cycle of modulation, the pulses occur at longer intervals producing a lower voltage at the output of the filter. See Figure 4-4, detail C. The output of the filter follows the frequency modulation of the IF signal. The resulting audio signal is fed to the VOLUME control and to the Oscilloscope or FM Deviation Meter for an indication of the amount of modulation.

When the monitored signal is of sufficient amplitude, a dc control voltage from the Broadband Mixer or Preselector, turns on Schmitt trigger Q6 and Q7. This results in switch Q8 supplying a ground to the one-shot multivibrator and the SIGNAL LEVEL lamp, turning them on. Thus, reliable measurements can be made providing the signal is of sufficient level.

Two controls are provided to adjust the zero reading of the FREQUENCY meter. Potentiometer R30 is for coarse calibration of the bridge and frequency measuring circuit. The front panel CAL. control (FP-R1-1) is for fine calibration and completes the bridge circuit.

When the CE-7 is used as a CW- or FM-signal generator, the action of the second IF and discriminator circuits is the same as described for the measuring mode. The 10-MHz input to the board, however, originates on the Multi-Oscillator board and the output is amplified in the Broadband Mixer or Preselector (last two stages). After amplification the signal is fed to the second mixer in the Second IF and Discriminator board.

4.3 Power-Supply Board

The CE-7 contains three power supplies providing regulated outputs of +5 volts, +20 volts, and -12 volts. Refer to Figure 4-5 for the block diagram and Figure 6-2 for the schematic diagram of the Power Supply board. AC power is fed through power transformer secondary windings to the +20- and -12-volt rectifiers. The 117-volt AC line power is fed directly to the oven control circuit.

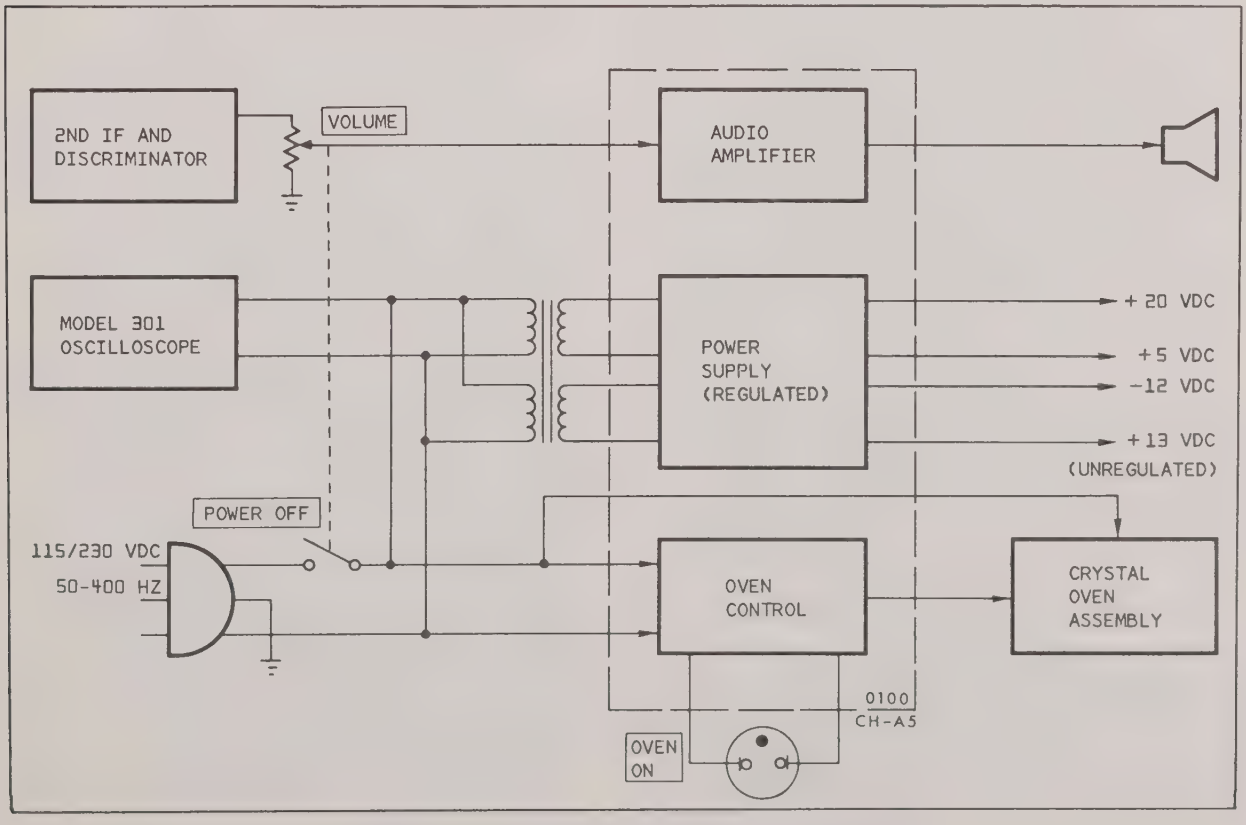


Figure 4-5. Power-Supply Board, Block Diagram

The +20-volt regulator consists of: bridge connected rectifiers CR1, CR2, CR3, CR4; a filter capacitor, C1; a constant current source, Q1; series regulators, Q3 and CH-Q1; a reference element, CR6; differential amplifiers, Q5 and Q6; a dc amplifier, Q4; and an over-current protection circuit, Q2. Potentiometer R9 is the control for adjusting the +20-volt supply to the proper voltage.

The -12-volt supply is similar and the unregulated +13-volt supply is simply the fused output of the bridge rectifiers for the -12-volt supply. Potentiometer R27 is the control for adjusting the -12-volt supply to the proper voltage. The +5-volt supply is derived through means of zener diode CR7 from the +20-volt supply.

The audio input from the VOLUME control is amplified by IC1 and fed to the speaker.

The oven-control circuit controls the AC power supplied to the heat windings of the oven. Fast heat is controlled by the snap-action thermostat which opens at 65°C. Regular heat is controlled by the mercury column thermostat which closes at 76.2°C and shorts out gate Q13, which shuts off the triac and removes the power from the winding. When the temperature drops below 76.2°C, the column opens. This permits the triac to be triggered on the next time the AC voltage goes through zero. The front panel OVEN ON lamp is energized whenever the regular heat is on.

The Crystal Oven Assembly (Figure 6-9) is protected against overheating by thermal fuse TF1. Any time the temperature inside the oven exceeds 81.1°C, thermal fuse TF1 will open and cause the oven to become inoperative.

4.4 Frequency Error Meter Board

Figure 6-3 is the schematic diagram of the Frequency Error Meter board. The push-pull dc outputs from the discriminator and lowpass filter are routed through the FREQUENCY BELOW 40 MHz - ABOVE 40 MHz switch. The switch reverses the polarity of the signals to the meter as the LO is above or below the desired signal to be monitored or generated. The signals are then routed through the function switch, the EXT. METERS switch located on the rear panel, the ±kHz (FREQUENCY lever) switch, and to the calibration potentiometers.

In the FREQ.-DEV. MEASURE position of the function switch the range of operation of the meter is selectable by the ±kHz (FREQUENCY lever) switch for ±0.5 kHz, ±1.5 kHz or ±5.0 kHz. In the FM or CAL./CW positions of the function switch, the inputs to the meter are through specific resistors to provide fixed ranges of ±0.5 kHz, and ±5.0 kHz, respectively. Diodes CR1 and CR2 provide meter protection in the event of overdrive.

In the HARM. AMP. TUNING position of the function switch, one side of the meter is grounded and the other side is supplied with the dc tuning voltage coming from the Harmonic Generator board.

4.5 Harmonic Generator Board

Figure 4-6 is the block diagram and Figure 6-4 is the schematic diagram of the Harmonic Generator board. Depending on customer requirements, up to 23 crystals in a frequency range of from 6.2 MHz to 9.4 MHz can be installed in the Crystal Oven Assembly. Any one of these can be selected by the CARRIER FREQUENCY SELECTOR switch. The selected crystal is capacitively coupled to the modifed Colpitts oscillator Q8, and amplified by Q7. The output of Q7 is fed to both limiter Q5 and emitter follower Q6; the latter feeds the CRYSTAL OUT AUX. IN connector. This connector is a convenient monitoring point for measuring the frequencies of the crystals and also serves as the input connector for inputs from external crystals (Model MCO-6 Multi-Channel Oscillator). Whether an internal or an external crystal is used as a signal source, the signal is passed through limiter Q5, and capacitively coupled to tuned amplifiers Q1 and Q2. The 6.2 MHz to 9.4 MHz signals are multiplied by Q1 and tuned by Q2 to give a frequency range of

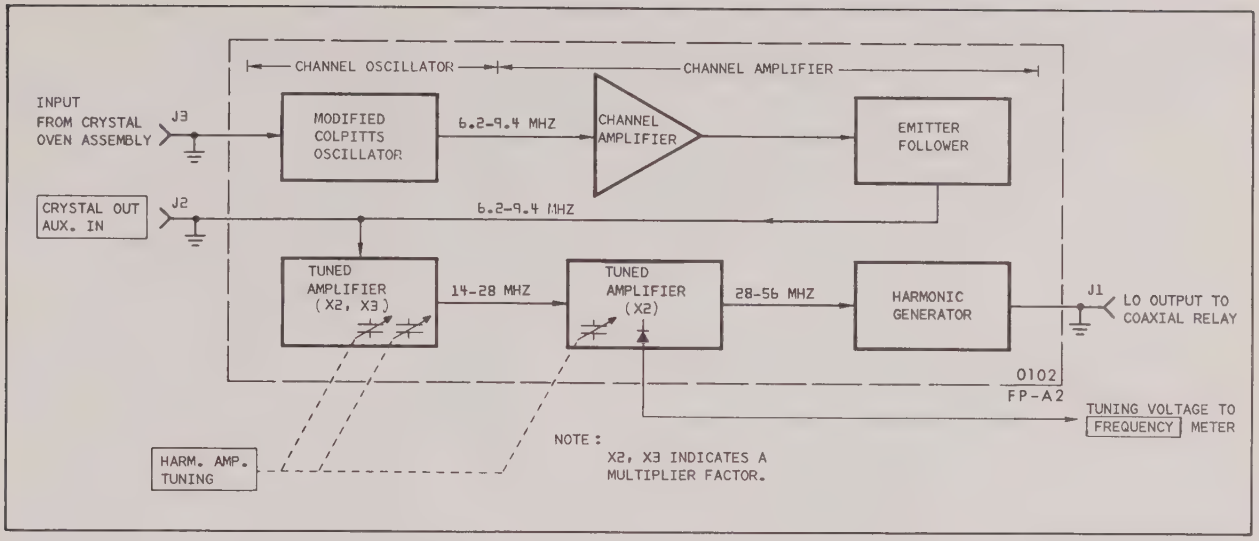


Figure 4-6. Harmonic-Generator Board, Block Diagram

from 14 MHz to 28 MHz. This frequency range is doubled by CR1 and CR2 and amplified by tuned amplifier Q3, to achieve a signal in the range of from 28 MHz to 56 MHz.

This signal is matched by emitter follower Q4 to the low impedance of step-recovery diode CR4. The step-recovery diode conducts during the positive half of the input-signal and stores that charge. During the negative half it is quickly driven towards cutoff and snaps back to form an extremely narrow pulse that is rich in harmonics.

The fundamental frequency output is 28 MHz to 56 MHz and the harmonics are usable to 1150 MHz. These pulses and the resulting harmonics form the LO signal. See Table 4-1. The board output feeds coaxial relay CH-K1. Diode CR3 rectifies a sample of the fundamental frequency range of the harmonic generator that is filtered to form the dc tuning voltage which drives the FREQUENCY meter when the harmonic amplifier is being tuned by the variable capacitors (C5). The capacitors are connected to the HARM. AMP. TUNING control. Transformers T1, T2, and T3, and the trimmer capacitors (C6) are adjusted such that the tuned amplifiers linearly follow (track) the manual tuning.

The Channel Frequency Chart (Table 4-1) provides a means to determine the crystal frequency when the channel frequency is known. Locate the applicable channel frequency range in the CHANNEL FREQUENCY RANGE column. Add or subtract 10 MHz as indicated in the ADD OR SUBTRACT 10 MHz column to determine the first LO frequency required. The resultant frequency should be within the range in the LO FREQUENCY RANGE column. Divide the LO frequency by the number given in the DIVIDE BY column. The resultant frequency is the crystal frequency required and should be within the range in the CRYSTAL FREQUENCY RANGE column.

Example:

153.123 MHz	-	Assigned frequency
10.000 MHz	-	Subtract
143.123 MHz	-	1st LO frequency
143.123 ÷ 18	-	Divide by
7,951.277 kHz	-	Crystal frequency

Table 4-1. Channel-Frequency Chart

CHANNEL FREQUENCY RANGE (MHz)			ADD OR SUBTRACT 10 MHz	L.O. FREQUENCY RANGE (MHz)			DIVIDE BY	CRYSTAL FREQUENCY RANGE (kHz)		
18.0	to	27.4	Plus 10 MHz	28.0	to	37.4	4	7,000	to	9,350
27.4	to	40.0	Plus 10 MHz	37.4	to	50.0	6	6,233	to	8,333
40.0	to	47.4	Minus 10 MHz	30.0	to	37.4	4	7,500	to	9,350
47.4	to	66.0	Minus 10 MHz	37.4	to	56.0	6	6,233	to	9,333
66.0	to	84.8	Minus 10 MHz	56.0	to	74.8	8	7,000	to	9,350
84.8	to	122.0	Minus 10 MHz	74.8	to	112.0	12	6,233	to	9,333
122	to	178	Minus 10 MHz	112	to	168	18	6,222	to	9,333
178	to	234	Minus 10 MHz	168	to	224	24	7,000	to	9,333
234	to	290	Minus 10 MHz	224	to	280	30	7,467	to	9,333
290	to	346	Minus 10 MHz	280	to	336	36	7,778	to	9,333
346	to	402	Minus 10 MHz	336	to	392	42	8,000	to	9,333
402	to	514	Minus 10 MHz	392	to	504	54	7,260	to	9,333
514	to	626	Minus 10 MHz	504	to	616	66	7,637	to	9,333
626	to	794	Minus 10 MHz	616	to	784	84	7,333	to	9,333
794	to	1018	Minus 10 MHz	784	to	1008	108	7,260	to	9,333
1018	to	1186	Minus 10 MHz	1008	to	1176	126	8,000	to	9,333

4.6 Multi-Oscillator Board

Figure 4-7 is the block diagram and Figure 6-5 is the schematic diagram of the Multi-Oscillator board. The Multi-Oscillator board consists of: 10-MHz, 9.9-MHz and 1.0-kHz oscillators; an amplifier for up to ten plug-in IF oscillators; and a 10-MHz frequency modulator.

Whenever a frequency is selected (measuring mode as well as signal generating modes) the crystal oscillator associated with that frequency is activated. As has been stated, the output of each crystal oscillator is always mixed with a 10-MHz signal to produce the LO signal. This 10-MHz signal is generated by transistor Q1 in conjunction with a 10-MHz crystal which is located in the Crystal Oven Assembly. The 10-MHz oscillator is energized by +20 volts when the function switch is in the CAL./CW position. Its output is amplified by Q2 and fed to emitter follower Q3 . The signal is then fed through a 12-dB impedance matching circuit and emitter follower Q9 to tuned amplifier Q10. The output of Q10 is fed to the Broadband Mixer or Preselector and is used as a reference signal to zero the FREQUENCY meter. It is also fed to the Signal Generator Step Attenuator.

To modify the LO signal so that it can be used as a signal generator output, another 10-MHz signal must be mixed with the LO signal. This 10-MHz signal is generated by voltage-controlled oscillator Q7, which is energized by +20 volts when the function switch is in the FM position.

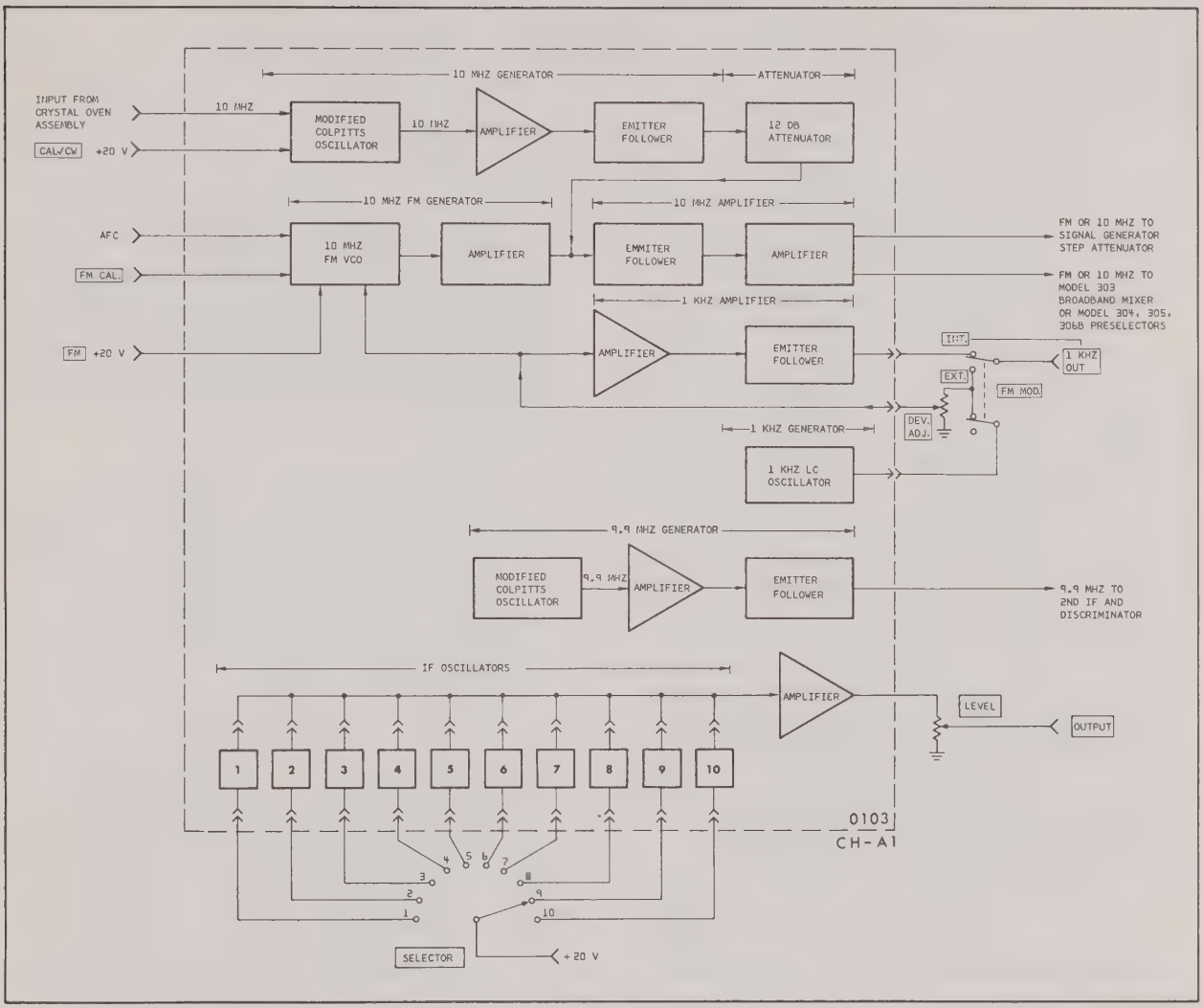


Figure 4-7. Multi-Oscillator Board, Block Diagram

Its frequency is set to 10 MHz with the FM CAL. control FP-R5, which adjusts the voltage to Varicap CR2 in the tuned circuit of the oscillator. When adjusted to exactly 10 MHz, the oscillator frequency is kept constant by the AFC voltage from the frequency-error-detector circuit in the Second IF and Discriminator board which is also applied to Varicap CR2.

The internally-generated modulating signal (for FM signal generation) is produced by the 1-kHz oscillator. Transistor Q4 in this oscillator circuit is energized when +20 volts is applied by turning the FM MOD. switch to the INT. position. The output of the oscillator is fed to the DEV. ADJ. potentiometer, which provides adjustment for the amount of signal being delivered to Varicap CR2 of oscillator Q7 and via amplifier Q5 and emitter follower Q6, to the 1-kHz OUT connector. The Varicap changes capacitance and thus frequency-modulates the 10-MHz output of Q7.

To produce a second-IF signal of 100 kHz, the first IF of 10 MHz is mixed with a 9.9-MHz signal. This signal is produced by crystal-controlled oscillator Q13. The 9.9-MHz crystal is not installed in the Crystal Oven Assembly but operates at ambient temperatures. Transistor Q13 is always energized except when the

function switch is in the I. F. position. Its output is amplified by Q14 and Q15, and fed to the buffer amplifier in the Second IF and Discriminator board where it is mixed with the first IF signal.

4.7 IF Oscillator Board

The Multi-Oscillator board provides 10 receptacles into which IF oscillator boards may be inserted at the option of the customer. Refer to Figure 4-7. The frequencies that may be selected for these crystal-controlled oscillators lie in ranges of from 250 kHz to 900 kHz (see Figure 6-6) and from 1 MHz to 13.5 MHz (see Figure 6-7). When the function switch is in the I. F. position, the I. F. GENERATOR SELECTOR may be turned to one of its numbered positions (1 through 10), thus a +20-volt energizing voltage is applied to the corresponding receptacle. The output of the activated oscillator circuit is amplified by Q11 and Q12, and is available at the I. F. GENERATOR OUTPUT connector. If additional IF frequencies are needed or if it is desirable to change the frequency that is available in a particular position of the SELECTOR, refer to Paragraph 3.4.5 for installation and removal of IF Oscillator boards.

4.8 Signal-Generator Mixer

Figure 6-8 is the schematic diagram of the Signal Generator Mixer. The LO signal which reaches the Signal Generator Mixer from the Harmonic Generator board via the coaxial relay (CH-K1) consists of narrow pulses with a frequency between 28 MHz and 56 MHz. This LO signal is mixed with a second input signal with a 10 MHz frequency from the Signal Generator Step Attenuator. The resultant signals are coupled out to the SIGNAL GENERATOR OUTPUT connector.

If the desired signal output is below 40 MHz then the Harmonic Generator output is higher than the desired signal by 10 MHz and the lower sideband is used, and vice-versa for the above. The FREQUENCY BELOW 40 MHz - ABOVE 40 MHz switch should be switched accordingly for proper readout.

The multi-turn LEVEL SET control feeds a dc voltage to mixer-diode CR1 and forward-biases it at different currents for calibrating the signal generation output in the different communications frequency bands.

SECTION 5
MAINTENANCE

5.1 Introduction

This section contains the necessary procedures to perform adjustments and troubleshooting of the CE-7. If adjustments other than those described are required, it is recommended that the instrument or subassembly be returned to Cushman Electronics, Customer Service Department for calibration and alignment.

It is assumed that the operator is familiar with the operating procedures described in Section 3. The instrument should be warmed up for at least 30 minutes before any adjustment or troubleshooting is attempted. For most of the tests and internal adjustments, the side covers and bottom cover must be removed. The test equipment required for each adjustment is given after preliminary instructions (Paragraphs 5.4.1 through 5.4.6). For ease of following the adjustment procedures or checks, the steps are given in tabular form (Tables 5-2 through 5-7). Troubleshooting guides also in tabular form (Tables 5-8 through 5-11) are provided to assist the operator in localizing malfunctions. Interior views of the instrument are included to aid in locating the various test and adjustment points.

5.2 Access

Components in the top part of the instrument can be reached by removing the two L-shaped side covers. Each cover is secured to the chassis by six screws. The speaker leads must be disconnected before the right-hand cover can be removed completely. Components in the bottom part of the instrument can be reached by setting the CE-7 on its rear panel, with the bottom facing forward. The bottom cover is secured to the chassis by six screws.

The Model 302 FM Deviation Meter or the Model 301 Oscilloscope is removed by loosening a small knob on the rear panel of the CE-7 and pushing in on this knob. The Model 303 Broadband Mixer and Models 304, 305, or 306B Preselector are removed by loosening the LOCK knob on the front panel of the plug-ins, and pushing in on the knob to disengage the plug-in connector from the CE-7 receptacle.

5.3 Fuses

There are three regulated power supplies within the CE-7: +5 volts, +20 volts, and -12 volts. The +5-volt supply is derived by means of a zener diode from the +20-volt supply and does, therefore not have a separate adjustment or fuse. Separate fuses and adjustments for the -12- and +20-volt supplies are on Power Supply board 0100 located on the right side of the instrument. See Figure 5-1. The -12- and +20-volt supplies are protected by 1.0 amp slo-blo fuses. The upper-adjusting potentiometer and upper fuse are for the +20-volt supply. The lower-adjusting potentiometer and lower fuse are for the -12-volt supply. If one of these fuses blows, the resistance between the regulator output terminal and ground should be measured to make sure that there is not a short circuit. Table 5-1 gives the approximate resistances to chassis ground for each supply (or, in the case of the plug-ins, for the load across each supply).

There are two separate AC fuses located on the rear panel of the CE-7. A 1.0 amp slo-blo fuse is for the main AC power to the instrument. The other is a 0.2 amp slo-blo fuse that provides protection to the Model 301 Oscilloscope, which has a regulated power supply.

5.4 Adjustment Procedures and Check

The following paragraphs (5.4.1 through 5.4.6) interspersed with their respective tables provide preliminary instructions and test equipment required for performance of the tests given to maintain the CE-7.

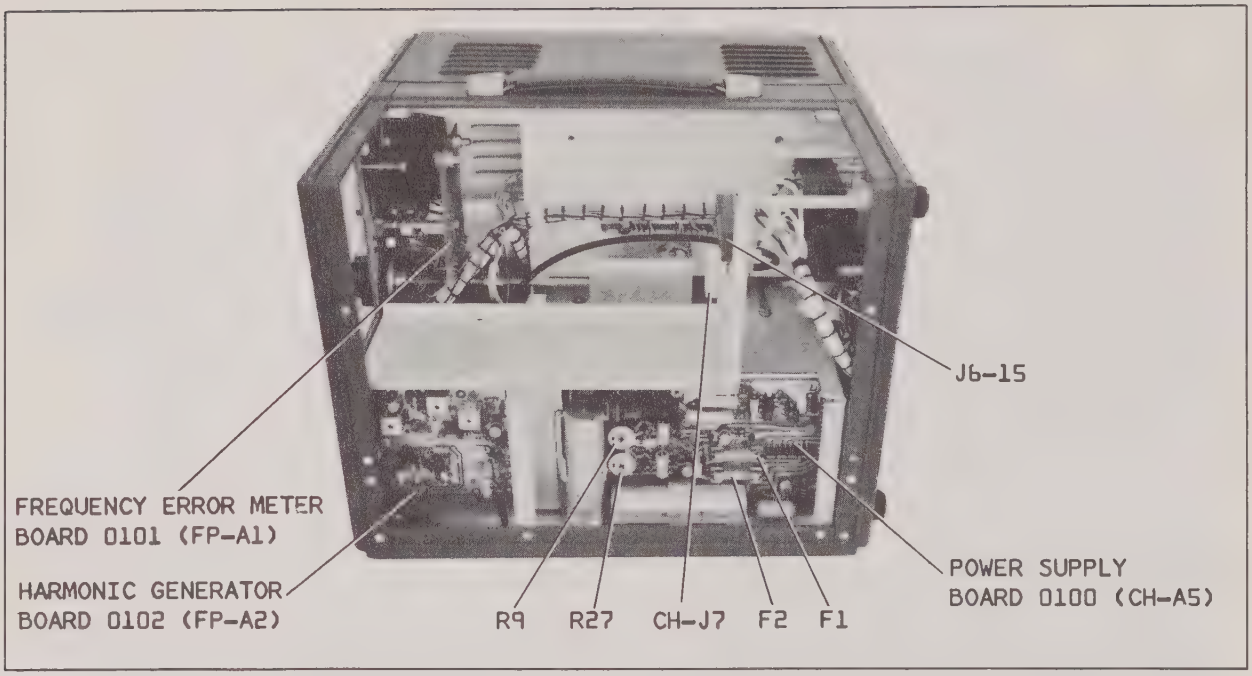


Figure 5-1. CE-7 Right Interior View Without Plug-In

5.4.1 Power-Supply Board, Voltage Adjustment

Preliminary Instructions:

Adjustments for the power supplies (Table 5-2) are on Power Supply Board 0100 (CH-A5) located on the right side of the instrument. See Figure 5-1.

NOTE

The -12-volt and +20-volt regulated power supplies are factory set to within 0.5 percent of rated output voltage and should not be changed unless a voltmeter having an accuracy of at least 1.0 percent is used.

Test Equipment Required:

a. Volt-Ohm-Milliammeter, Simpson Model 270 or equivalent. (20,000 ohms-per-volt or higher sensitivity, 1.0 percent accuracy, +5V and -50V ranges.)

b. VTVM, Hewlett-Packard Model 400H.

5.4.2 Crystal-Oscillator Adjustment

Preliminary Instructions:

a. The crystals and trimmer capacitors for each of the 23 channels are in the Crystal Oven Assembly (CH-A4). Access to the trimmer capacitors is through the bottom of the instrument. See Figure 5-2. The Crystal Oven Assembly cover has a revolving disc with one tuning hole, which can be rotated to line up with the access holes for each of the 23 crystal trimmers. The tuning tool used to adjust the trimmer capacitors must be an insulated female-slotted tuning driver. Refer to Table 5-3 for Crystal Oscillator Adjustment procedures.

b. A separate 10-MHz crystal, also located in the Crystal Oven Assembly (see Figure 5-2), is used when the function switch is in the CAL./CW position. Its trimmer capacitor access hole is located diagonally above crystal position 21 on the Crystal Oven Assembly cover.

c. Place the instrument on its rear panel with the Crystal Oven Assembly facing forward.

Test Equipment Required:

a. Frequency Counter, Hewlett-Packard Model 5245L, or equivalent.

b. Tuning Tool, GC Electronics No. 8279.

c. Signal Generator, Hewlett-Packard Model 608 or 612.

5.4.3 Frequency-Meter Adjustment

Preliminary Instructions:

a. Balancing the Second IF and Discriminator board 0054 (CH-A2) should precede adjustment of the FREQUENCY meter. Perform the following CAL. and FM CAL. centering adjustments.

NOTE

The SIGNAL LEVEL lamp must be on before proper adjustments can be performed.

Table 5-1. Power Supply, Resistances to Ground

	+5V (green wire)		-12V (orange wire)		+20V (red wire)	
	Measured at	Res. (ohms)	Measured at	Res. (ohms)	Measured at	Res. (ohms)
CE-7 Monitor† (less plug-ins)	Pin 15 of RF plug-in receptacle	750-1700*	Pin 14 of RF plug-in receptacle	400-450	Pin 17 of RF plug-in receptacle	500-550
Model 301 Oscilloscope	Not used	--	Pin 14 of connector	4.5K-7.5K††	Pin 13 of connector	1.5K-1.8K*
Model 302 Deviation Meter	Not used	--	Pin 14 of connector	8.2K-8.5K*	Pin 13 of connector	1.7K
Model 303 Broadband Mixer	Pin 15 of connector	3.5K*	Pin 14 of connector	500	Pin 16 of connector Pin 17 of connector	1.8-2.4K*††† 10K*
Model 304 Preselector	Pin 14 of connector	1.25K-50K*	Pin 14 of connector	265	Pin 16 of connector Pin 17 of connector	800 22K-30K*
Model 305 Preselector	Pin 15 of connector	1.25K-50K*	Pin 14 of connector	265	Pin 16 of connector Pin 17 of connector	3.8K 24K
Model 306B Preselector	Pin 15 of connector	5.3K	Pin 14 of connector	500	Pin 16 of connector Pin 17 of connector	3K 12K

NOTE: All resistance readings taken with a Simpson 270 using RX100 scale.
All resistance readings of modules taken with module removed from set.

*Depended on ohmmeter test-lead polarity. The readings may also vary depending upon ohmmeter range.

†Measure resistance to chassis of supply lines.

††Resistance readings taken with "vernier" pot in mid position.

†††Resistance readings taken with selectivity switch in "normal".

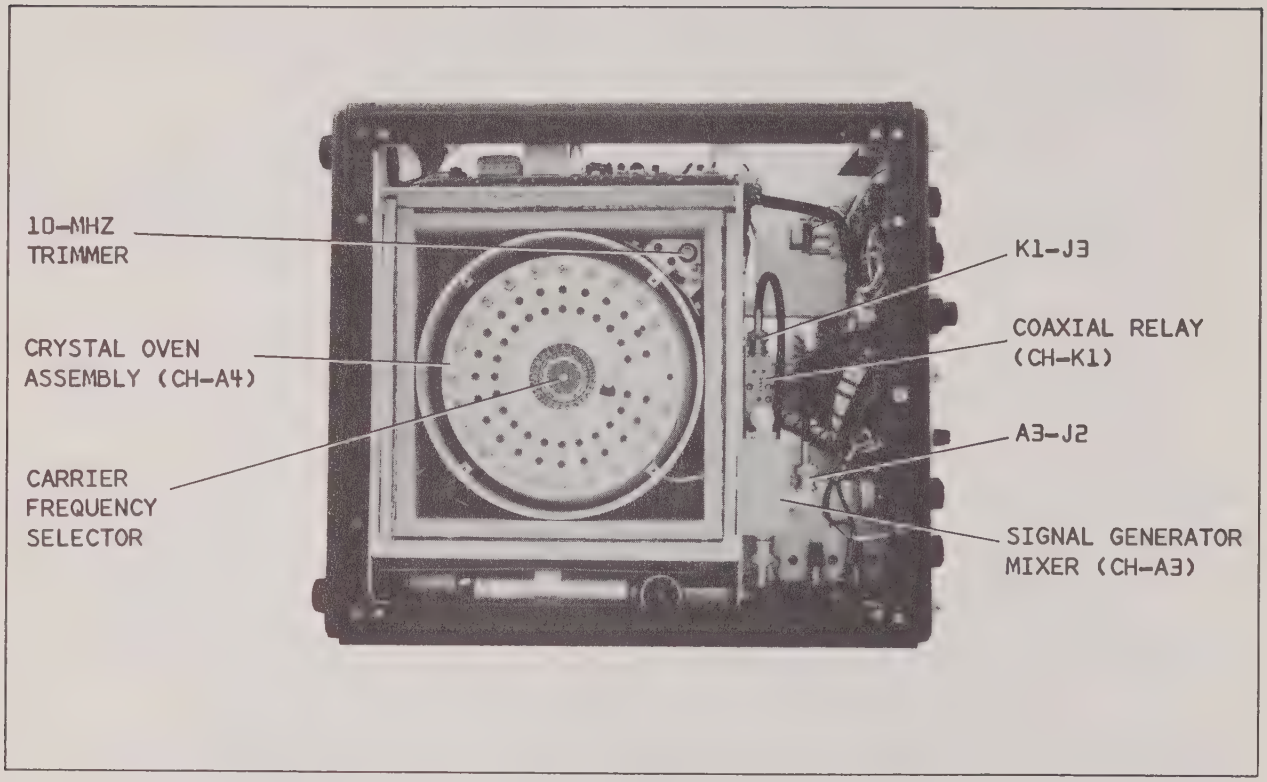


Figure 5-2. CE-7 Bottom Interior View

Table 5-2. Power-Supply Board, Voltage Adjustment

STEP	FUNCTION	TEST POINT OR ADJUSTMENT	PERFORMANCE STANDARD
1A	Measure -12-volt supply to chassis ground (see Figure 5-3).	TB1-3 (orange wires)	-12 volts
1B	Adjust lower potentiometer (see Figure 5-1).	R27 (CH-A5)	-12 volts
2A	Measure +20-volt supply to chassis ground (see Figure 5-3).	TB1-1 (red wires)	+20 volts
2B	Adjust upper potentiometer (see Figure 5-1).	R9 (CH-A5)	+20 volts
3A	Measure +5-volt supply (see Figure 5-1).	CH-J6-15 (green wires)	Between 4.8 and 5.2 volts.
4A	Measure -12- and +20-volt ripple at test points specified in steps 1A and 2A with vtvm.		Less than 1.0 millivolt.

Table 5-3. Crystal-Oscillator Adjustment

STEP	FUNCTION	TEST POINT OR ADJUSTMENT	PERFORMANCE STANDARD
1A	Connect input of the counter to the CRYSTAL OUT/AUX. IN connector. **CAUTION** The level at this point is approximately 200 millivolts into 50Ω (0.2 volts). Ensure that the counter can be used at this level.		The crystal frequency selected should be within 3.0 Hz of the specified frequency.
1B	Set CARRIER FREQUENCY SELECTOR to "1".		
1C	Align rotating oven disc to position "1".		
1D	With the tuning tool, adjust trimmer to the crystal frequency listed on the Channel Frequency Chart.	Appropriate Trimmer Capacitor.	Crystal frequency listed for position "1" on Channel Frequency Chart.
1E	Repeat steps 1A through 1D for each of the other 22 crystals. NOTE The following steps are to be performed when installing new, or changing crystals.		
2A	Connect the output of the signal generator to the ANT. connector of the RF plug-in being used.		
2B	Set the signal generator to the approximate frequency of the carrier channel desired.		
2C	Adjust the output level of the signal generator to approximately 20 millivolts.		
2D	Set the function switch to HARM. AMP. TUNING and CHANNEL FREQUENCY SELECTOR to the carrier channel desired.		
2E	Rotate the HARM. AMP. TUNING control fully counterclockwise.		

Table 5-3. Crystal-Oscillator Adjustment (Continued)

STEP	FUNCTION	TEST POINT OR ADJUSTMENT	PERFORMANCE STANDARD
2F	Rotate the HARM. AMP. TUNING control slowly clockwise to the first peak reading on the FREQUENCY meter.		
2G	Set the function switch to FREQ.-DEV. MEASURE and ensure that the SELECTIVITY switch is in the NORMAL position.		
2H	Set the ±kHz (FREQUENCY lever) to 5 and the FREQUENCY BELOW 40 MHz - ABOVE 40 MHz control to the appropriate position.		
2J	Vary the signal generator around the channel frequency until the SIGNAL LEVEL lamp lights. NOTE False responses may be encountered when varying the signal generator frequency too far above or below the assigned frequency.		
2K	If the SIGNAL LEVEL lamp does not light, the HARM. AMP. TUNING control may be tuned to the wrong peak.		
2L	Set the function switch to HARM. AMP. TUNING and rotate the HARM. AMP. TUNING control slowly clockwise to the next peak. Repeat steps 2G through 2J.		
2M	When the SIGNAL LEVEL lamp lights, center FREQUENCY meter with signal generator frequency control. NOTE Ensure that the FREQUENCY meter deflects towards the plus (+) side when increasing the signal generator frequency.		

Table 5-3. Crystal-Oscillator Adjustment (Continued)

STEP	FUNCTION	TEST POINT OR ADJUSTMENT	PERFORMANCE STANDARD
2N	Reduce the output level of the signal generator until the SIGNAL LEVEL lamp goes out.		
2P	Slowly increase the signal generator output level until the SIGNAL LEVEL lamp lights.		Sensitivity less than 5 millivolts if operating below 500 MHz, less than 10 millivolts if operating above 500 MHz (using a Broadband Mixer). NOTE When using one of the RF Pre-selectors the sensitivity should be less than 20 microvolts.
2Q	Record the number indicated on the HARM. AMP. TUNING control on the Channel Frequency Chart. NOTE The following steps are to be performed for the 10-MHz adjustment.		
3A	Disconnect coaxial connector atop Signal Generator Mixer, which is above the Crystal Oven Assembly. (See Figure 5-2.)	CH-A3-J2	
3B	Connect the coaxial connector (A3-J2) to the input of the counter with a suitable adapter.		
3C	Set the function switch to CAL./CW.		
3D	Set the SIGNAL GENERATOR attenuator multiplier to X100 and vernier control for maximum output.		
3E	Adjust 10-MHz trimmer with tuning tool.	Trimmer Capacitor.	10.0 MHz ±10.0 Hz as indicated on counter.
3F	Reconnect coaxial connector to Signal Generator Mixer.		

CAL. centering:

1. Set the function switch to CAL./CW.

2. Set the CAL. control (inner red knob) to a twelve o'clock position.

3. Adjust R30 on the Second IF and Discriminator Board 0054 (CH-A2) for a zero reading on the FREQUENCY meter. Refer to Figure 5-3.

FM CAL. centering:

1. Set the function switch to CW.

2. Zero FREQUENCY meter with the CAL. control.

3. Set the function switch to FM.

4. Turn the DEV. ADJ. control fully counterclockwise.

5. Set the FM CAL. control (inner red knob) to a ten o'clock position.

6. Adjust L5 on the Multi-Oscillator Board 0103 (CH-A1) through the access hole in the left frame of the chassis (remove FM Deviation Meter or Oscilloscope) for a zero reading on the FREQUENCY meter. Refer to Figure 5-3.

b. The FREQUENCY meter ranges are adjusted by means of an oscillator which can be offset from 10 MHz by exactly ±0.5 kHz, ±1.5 kHz, and ±5.0 kHz. Refer to Table 5-4. The CE-7 first IF is 10 MHz and its discriminator will detect and display frequency error above or below this frequency.

c. The Model 303 Broadband Mixer must be installed in the CE-7 before any adjustments can be performed.

d. On the Frequency Error Meter board 0101 (FP-A1) mounted on the back of the FREQUENCY meter are three potentiometers. The top one (R2) is for ±0.5 kHz, the middle one (R4) for ±1.5 kHz, and the bottom one (R6) for ±5.0 kHz. See Figure 5-3.

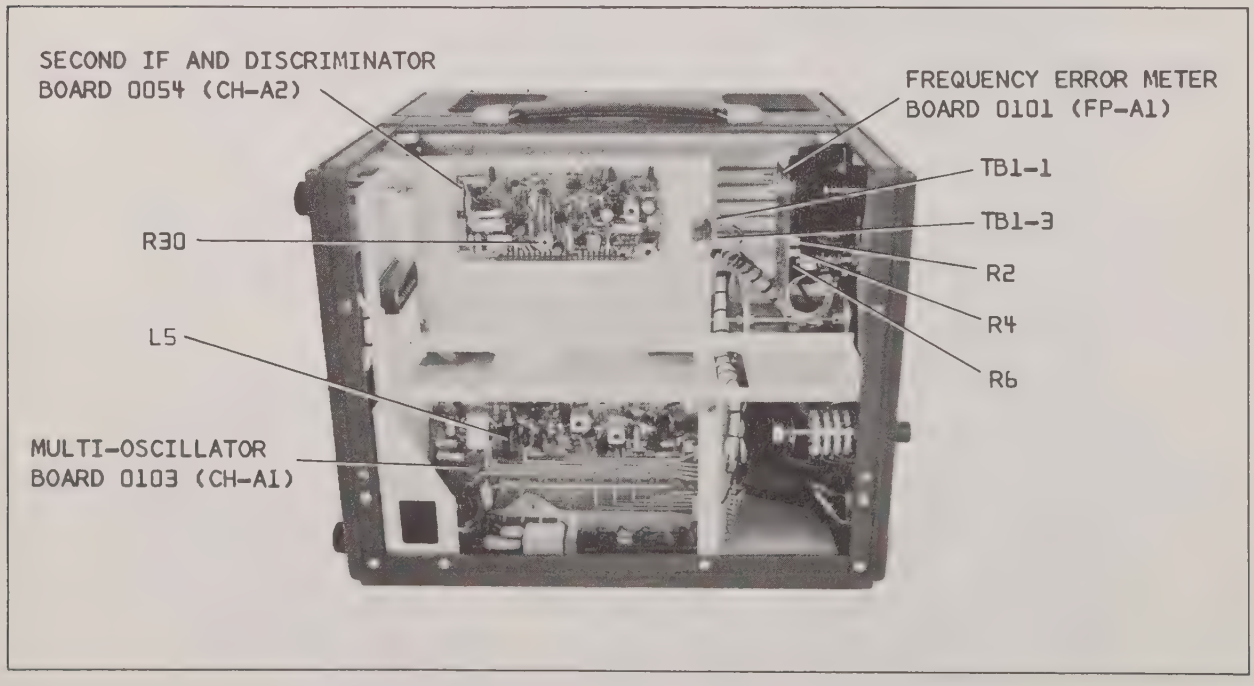


Figure 5-3. CE-7 Left Interior View Without Plug-In

Test Equipment Required:

a. Signal Generator, Hewlett-Packard Model 606.

b. Frequency Counter, Hewlett-Packard Model 5245L.

c. Tuning Tool, JFD Electronics Co., No. 5284.

Table 5-4. Frequency-Meter Adjustment

STEP	FUNCTION	TEST POINT OR ADJUSTMENT	PERFORMANCE STANDARD
1A	Set the function switch to CAL./CW and zero the FREQUENCY meter with the inner red control knob.	R1	
1B	Set the FREQUENCY BELOW 40 MHz - ABOVE 40 MHz switch to ABOVE 40 MHz.	S3	
1C	Set the function switch to FREQ.-DEV. MEASURE and connect the output of the signal generator to both the input of the Model 303 Broadband Mixer and input of the counter (using a "T" adapter). NOTE The SIGNAL LEVEL lamp must be on before proceeding with steps 1D through 1G.		
1D	Set the ±kHz (FREQUENCY lever) to .5.	S2	
1E	Adjust the signal generator to 10,000,500 Hz.		0.5 kHz as indicated on FREQUENCY meter.
1F	Adjust the top (0.5 kHz) potentiometer for full scale.	R2 (FP-A1)	
1G	Repeat steps 1D through 1F but adjust the signal generator to 10,001,500 Hz when the ±kHz (FREQUENCY lever) is set to 1.5, and 10,005,500 Hz when the ±kHz (FREQUENCY lever) is set to 5.	R4 (FP-A1) and R6 (FP-A1)	1.5 kHz and 5.0 kHz as indicated on FREQUENCY meter.

5.4.4 20-dB Fixed-Attenuator Loss Check

Preliminary Instructions:

a. A 20-dB fixed attenuator is supplied with the CE-7 and is stored inside the front cover. The CE-7 attenuators are calibrated in terms of signal voltage at the output of the 20-dB fixed attenuator. Refer to Table 5-5. The fixed attenuator must therefore, always be used if the output levels indicated by the position of attenuator knobs are to mean anything. The purpose of the fixed attenuator is to protect the instrument when the CE-7 is directly connected to a transceiver which is accidentally keyed to transmit. Keying a transmitter will normally burn out the RF fuse. But before the fuse blows, the resistors in the fixed attenuator may have been subjected to a transient overload severe enough to damage them and change their values. Changed ohmic values would cause changed attenuation.

Table 5-5. 20-dB Fixed-Attenuator Loss Check

STEP	FUNCTION	TEST POINT OR ADJUSTMENT	PERFORMANCE STANDARD
1A	Feed a 10-microvolt signal from the signal generator into the receiver.		
1B	Note the receiver meter reading.		
1C	Feed a 100-microvolt signal through the attenuator into the receiver.		
1D	Note the two receiver meter readings.		The two readings should be within 0.5 dB of one another.
	NOTE The 20-dB fixed attenuator loss may be checked using an RF Voltmeter such as the Boonton 91D in place of the receiver. Perform the following steps as required.		
2A	Connect the output of the signal generator into the RF Voltmeter through a 50Ω termination using a 50Ω coaxial cable.		
2B	Set the signal generator output level to approximately 100 millivolts and note the reading on the voltmeter.		
2C	Insert the 20-dB fixed attenuator between the signal generator and voltmeter, and note the difference in readings.		20 dB ±0.5 dB

b. Since it is essential that the fixed attenuation is precisely 20 dB, the checks listed in Table 5-5 must be performed if damage is suspected.

c. When it becomes necessary to repair the fixed attenuator, remove the single screw and slide the cover off. A decal on the side of the fixed attenuator casting shows the component values. The resistors are standard 5 percent values. The fuse is a special RF fuse (Bussman #GFA1/32A).

Test Equipment Required:

a. Signal Generator, Hewlett-Packard Model 608.

b. Metered receiver with 50Ω input impedances capable of operating at the required frequencies.

c. RF Voltmeter, Boonton Model 91D, or equivalent.

5.4.5 Signal-Generation-Output Level Adjustment

Preliminary Instructions:

a. The output levels are adjusted by signal substitution. Refer to Table 5-6. First, a signal from a calibrated source is fed into a metered receiver and the meter reading noted. The CE-7 is then substituted for the calibrated source and the output LEVEL SET control of the CE-7 is adjusted until the meter reads the same as before. The receiver should be metered at a point where saturation is least likely to occur (for example, the first and second IF stage) and the RF input signal should be preferably 1.0 microvolt.

b. Select a frequency at which the adjustment is to be made. This frequency must be within the capabilities of the external receiver, the external signal generator, and the CE-7.

c. Set the signal generator to this frequency by monitoring it on the CE-7.

NOTE

When using frequencies higher than 100 MHz, the signal generator must be tuned very slowly to accommodate the narrow bandwidth of the CE-7. If a Preselector is being used, ensure that its SELECTIVITY switch is set to NORMAL.

Test Equipment Required:

a. Signal Generator, Hewlett-Packard Model 608.

b. Metered receiver with 50Ω input impedances capable of operating at the required frequencies.

5.4.6 Signal-Generator-Mixer Input Level Check

Preliminary Instructions:

a. The signal generator mixer may be damaged in the same manner as noted for the 20-dB fixed attenuator (Paragraph 5.4.4). When it becomes necessary to repair the signal generator mixer, it will also be necessary to readjust the signal generator output levels (Table 5-6).

b. The two inputs to the signal generator mixer are: a 10-MHz signal from the Multi-Oscillator via the Signal Generator Step Attenuator, and a signal that may contain frequencies of from 28 MHz to 1150 MHz from the Harmonic Generator via the coaxial relay. Refer to Table 5-7.

Test Equipment Required:

RF Voltmeter, Boonton Model 91D.

Table 5-6. Signal-Generation-Output Level Adjustment

STEP	FUNCTION	TEST POINT OR ADJUST-MENT	PERFORMANCE STANDARD
1A	Adjust the signal generator output to 1.0 microvolt.		
1B	Feed the signal generator output into the receiver and note the receiver meter reading. (Be cautious of signal generator frequency drift.)		
1C	Set the function switch to CW. Adjust the CE-7 to generate a signal with a 1.0-microvolt level.		
1D	Disconnect the signal generator from the receiver, and connect the output of the CE-7 to the receiver. Use the 20-dB fixed attenuator furnished with the instrument.		
1E	If the receiver meter does not read the same as in step 1B, adjust the 10-turn LEVEL SET attenuator on the CE-7 for the same meter reading. Record the new LEVEL SET number on the Channel Frequency Chart. NOTE The LEVEL SET number for various frequencies in the same band will be the same. For this reason, it is not necessary to make the adjustments for every channel frequency.		Typical calibration frequencies are as follows: FREQUENCY BAND — NOMINAL FREQUENCY for CALIBRATION 20 to 80 MHz — 35 MHz 120 to 180 MHz — 155 MHz 450 to 512 MHz — 460 MHz 900 to 1000 MHz — 960 MHz
1F	Set the function switch to FM and center the FREQUENCY meter with the FM CAL. control. Turn the DEV. ADJ. control fully counterclockwise.		Less than 1.0 dB from CW reference.

Table 5-7. Signal-Generator-Mixer-Input Level Check

STEP	FUNCTION	TEST POINT OR ADJUSTMENT	PERFORMANCE STANDARD
	10 MHz INPUT LEVEL CHECK		
1A	Set the function switch to CW.		
1B	Disconnect the coaxial cable from the BNC connector atop the signal generator mixer (see Figure 5-2).	CH-A3-J2	
1C	Terminate RF voltmeter in 50Ω.		
1D	Measure cable output voltage.		200 millivolt ±2.0 dB (attenuator controls must be set at maximum output).
	COAXIAL RELAY LEVEL CHECK		
2A	Set the function switch to CW.		
2B	Disconnect the coaxial cable from left side of the coaxial relay (see Figure 5-2).	CH-K1-J3	
2C	Terminate RF voltmeter in 50Ω.		
2D	Set the function switch to HARM. AMP. TUNING.		
2E	Select any (used) channel with CARRIER FREQUENCY SELECTOR switch.		
2F	Tune HARM. AMP. TUNING control for maximum reading on FREQUENCY meter.		
2G	Measure cable output voltage		At least 700 millivolts.

5.5 Troubleshooting Procedures

The following tables (5-8 through 5-11) detail tests required to localize malfunctions in the CE-7. The malfunctions listed are not necessarily all of the problems that may be encountered. For further information, contact Cushman Electronics, Customer Service Department.

Table 5-8. Troubleshooting, Frequency-Deviation-Measure (FDM) Mode

TROUBLE	CHECK	NORMAL INDICATION	REFER TO
SELECTING PROPER CHANNEL			
Pilot light out	Lamp		Front panel of CE-7.
	Output of -12V regulator	-12V ±0.1V.	Power Supply Board 0100 (Figure 6-2).
	Fuse A5-F2		Power Supply Board 0100 (Figure 6-2).
	AC line fuse CH-F1		Rear panel of CE-7.
HARM. AMP. TUNING			
No meter movement	METERS INT.-EXT. slide switch position.	Set in INT. position.	Rear panel of CE-7.
	Channel crystal. (Select another crystal position and retune).	Greater than 0.3 on FREQUENCY meter.	Crystal Oven Assembly (Figure 6-9).
	Channel oscillator output at CRYSTAL OUT AUX. IN connector.	200 MV at FP-J4.	Harmonic Generator board 0102 (Figure 6-4).
	Harmonic amplifier output at SIGNAL GENERATOR OUTPUT connector.	700 MV at CH-A2-J1.	Harmonic Generator board 0102 (Figure 6-4).
	Wiring or loose contacts on function switch.		Front Panel Wiring diagram (Figure 6-11).
CAL./CW			
No SIGNAL LEVEL light or FREQUENCY meter indication.	RF Plug-in		Applicable instruction manual.
	10-MHz generator. (Try FM position on function switch.)	200 MV at CH-J1-14, R.	Multi-Oscillator board 0103 (Figure 6-5).
	+5V power supply.	+5.0V ±0.2V at CH-J6-15.	Power Supply board 0100 (Figure 6-2).
No SIGNAL LEVEL light indication. FREQUENCY meter OK.	Lamp and connector.	Lamp on in CAL./CW position.	Front Panel Wiring diagram (Figure 6-11).
SIGNAL LEVEL light on, no FREQUENCY meter deflection in CAL./CW.	METERS INT.-EXT. slide switch position.	Set in INT. position.	Rear panel of CE-7.
	Function switch or FREQUENCY meter movement.		Front Panel Wiring diagram (Figure 6-11).
	(Set function switch to FM and adjust DEV. ADJ. control for a reading on FM DEVIATION meter.) If normal, check L7 and L8.		Second IF and Discriminator board 0054 (Figure 6-1).
	Other positions on function switch.		Front Panel Wiring diagram (Figure 6-11).

Table 5-8. Troubleshooting, Frequency-Deviation-Measure (FDM) Mode (Continued)

TROUBLE	CHECK	NORMAL INDICATION	REFER TO
SIGNAL LEVEL light on, FREQUENCY meter reads off scale.	Output of -12V regulator	-12V ±0.1V at CH-J6-14.	Power Supply board 0100 (Figure 6-2).
	9.9 MHz generator.	80-100 MV at CH-J1-2, B.	Multi-Oscillator board 0103 (Figure 6-5).
NOTE The preceding trouble-shooting procedures also apply to the Signal Generator mode of operation.	Q4, Q5		Second IF and Discriminator board 0054 (Figure 6-1).
FREQ.-DEV. MEASURE			
Inoperative in this position only.	RF Plug-in or Broadband Mixer. Pin 7.	Greater than 600 MV.	Applicable instruction manual.
	Local oscillator connector or coaxial relay cable.	700 MV at CH-J7	Figure 5-1.
	Coaxial relay CH-K1 or Harmonic Generator output. (Listen for relay operation while switching function switch to different positions.)	700 MV at FP-A2-J1.	Figure 5-2, and Harmonic Generator board 0102 (Figure 6-4).
No audio, SIGNAL LEVEL light on. (Normal operation of FM Deviation Meter, Model 302.)	Speaker connection.	Audible tone in FM position.	Power Supply board 0100 (Figure 6-2).
	Audio amplifier.	1.0 audio at CH-A5-17 output with 50 MV input.	Power Supply board 0100 (Figure 6-2).
	Speaker.	3.0Ω dc resistance.	Right-hand side cover.
FREQUENCY meter operative but FM DEVIATION meter on Model 302 does not indicate or no trace on Oscilloscope, Model 301.	FM Deviation Meter or Oscilloscope		Applicable instruction manual.
	Q9	3.2 vdc	Second IF and Discriminator board 0054 (Figure 6-1).
CARRIER FREQUENCY SELECTOR			
Erratic FREQUENCY meter action in one or more of the crystal positions. NOTE This is also characteristic of the Signal Generator mode of operation.	Switch contacts on CARRIER FREQUENCY SELECTOR.		Figure 5-2.

Table 5-9. Troubleshooting, Signal-Generator Mode

TROUBLE	CHECK	NORMAL INDICATION	REFER TO
CAL./CW operative as verified in Table 5-4, but no output.	20-dB fixed attenuator.		20-dB fixed attenuator.
	Coaxial relay CH-K1. (Listen for relay operation while switching function switch to different positions.)		Figure 5-2.
	Harmonic amplifier output at SIGNAL GENERATOR OUTPUT connector.	Greater than 700 MV.	Front panel of CE-7.
	Signal Generator Mixer; local oscillator signal from coaxial relay CH-K1.	Greater than 700 MV at CH-A3-J1.	Figure 5-2.
	10-MHz signal from attenuator. (Defective function switch, attenuator, or wiring.)	200 MV at CH-A3-J2.	Front Panel Wiring diagram (Figure 6-11).
	Orange/white wire, (-12V bias diode CR1). LEVEL SET potentiometer or wiring.	-12V with LEVEL SET control set to zero.	Signal Generator Mixer (Figure 6-8).
No modulation. No indication on Model 302 FM Deviation Meter.	FM MOD. INT.-EXT. 1 kHz OUT switch.	Set to INT. position.	Front panel of CE-7.
	1 kHz generator. (1 kHz OUT connector with FM MOD. INT.-EXT. 1 kHz OUT switch in INT. position.)	Greater than 1.0V at FP-J2.	Front panel of CE-7.
	10-MHz FM Generator. Set FM MOD. INT.-EXT. switch to EXT. with external source of 1 kHz at 1.0V fed to EXT. connector.	Control of deviation with DEV. ADJ. control.	Multi-Oscillator board 0103 (Figure 6-5).
	Model 302 FM Deviation Meter.		Applicable instruction manual.

Table 5-10. Troubleshooting, I.F.-Generator Mode

TROUBLE	CHECK	NORMAL INDICATION	REFER TO
No output in all positions of the the SELECTOR switch.	IF Oscillator output.	600 MV at CH-J1-P.	Multi-Oscillator board 0103 (Figure 6-5).
600 MV not present at pin P on Multi-Oscillator board.	+20V to the selected IF Oscillator board position on the Multi-Oscillator board.	+20V ±0.1V.	IF Oscillator board 0104 (Figure 6-6) or 0105 (Figure 6-7).
	Q11 or Q12		Multi-Oscillator board 0103 (Figure 6-5).
	Wiring of SELECTOR switch.		Front Panel Wiring diagram (Figure 6-11).
600 MV present at pin P on Multi-Oscillator board.	Attenuator potentiometer and associated wiring.		Front Panel Wiring diagram (Figure 6-11).
No output in one position of the SELECTOR switch, all other OK.	+20V to selected IF Oscillator board.	+20V ±0.1V.	IF Oscillator board 0104 (Figure 6-6) or 0105 (Figure 6-7).
+20V present from SELECTOR switch.	Crystal or transistors.		IF Oscillator board 0104 (Figure 6-6) or 0105 (Figure 6-7).
+20V not present from SELECTOR switch.	SELECTOR switch wiring associated with that position.		Front Panel Wiring diagram (Figure 6-11).

Table 5-11. Troubleshooting, Crystal-Oven Assembly

TROUBLE	CHECK	NORMAL INDICATION	REFER TO
Excessive frequency error on all channels.			
OVEN ON light on continuously.	Shorted triac 40529, Q13.	Oven light on for approx. 30 seconds and off for approx. 90 seconds after warm-up.	Power Supply board 0100 (Figure 6-2).
	NOTE Thermal fuse TF1 blows if triac shorts.		
	Mercury column thermostat (regular heat).		
OVEN ON light will not energize. (Regular heat failure).	Blown thermal fuse TF1.		Crystal Oven Assembly (Figure 6-9).
	Open triac 40529, Q13.		Power Supply board 0100 (Figure 6-2).
	Snap-action thermostat (fast heat).		Crystal Oven Assembly (Figure 6-9).
	Mercury column thermostat.		Crystal Oven Assembly (Figure 6-9).
	OVEN ON light connector.		Front panel of CE-7.
OVEN ON light stays on for more than twenty minutes. (Slow warm-up noticed, but cycles normally after warm-up.)	Open snap-action thermostat.		Crystal Oven Assembly (Figure 6-9).
OVEN ON light cycles normally.	Mercury column thermostat.		Crystal Oven Assembly (Figure 6-9).
	Temperature with thermometer.	164°F.	

SECTION 6

PARTS LISTS, SCHEMATICS AND COMPONENT IDENTIFICATION DRAWINGS

INTRODUCTION

6.1 Each Parts List and Schematic Diagram is identified with the Circuit Reference number as well as the title name. Parts lists are grouped with the schematic diagrams to which they refer. Component identification drawings showing the location of the individual components on the circuit boards are placed on the inner sheet of the schematic diagrams to which they apply.

SECOND IF AND DISCRIMINATOR (CH-A2)

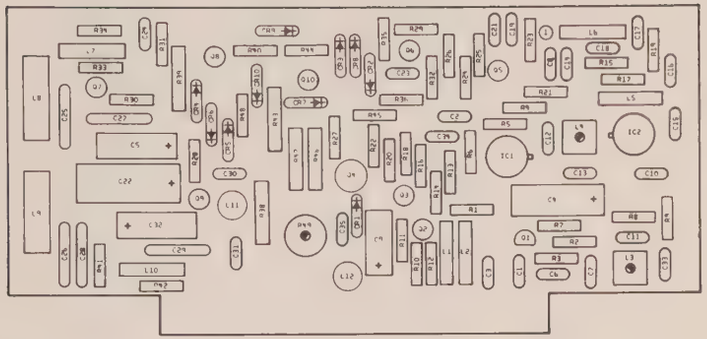
CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
CH-A2	Second IF and Discriminator Board Assy	7001-0011	Cushman	
	Printed Circuit Board	1780-0054	Cushman	
	CAPACITORS			
C1	Cer, .01μF, +80-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C2	Cer, .01μF, +80-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C3	Cer, .01μF, +80-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C4	Elect, 100μF, +75-10%, 12V	1013-0011	Sprague	30D107G012CC5
C5	Elect, 15μF, ±10%, 25V	1013-0005	Sprague	30D156G025BB5
C6	Cer, .01μF, +80-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C7	Cer, .01μF, +80-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C8	Cer, .05μF, +80-20%, 25V	1005-0014	Erie	5835-505-Y5U0-503Z
C9	Elect, 15μF, +75-10%, 12V	1013-0015	Sprague	30D156G012BA5
C10	Cer, 2.2pF, ±.25pF, 500V	1005-0017	Erie	301-000-C0J0-229C
C11	Mica, 430pF, ±5%, 500V	1002-0034	Elmenco	DM15-F-431J
C12	Mica, 430pF, ±5%, 500V	1002-0034	Elmenco	DM15-F-431J
C13	Cer, 3.3pF, ±.25pF, 500V	1005-0011	Erie	301-000-C0J0-339C
C14	Cer, .05μF, +80-20%, 25V	1005-0014	Erie	5835-505-Y5U0-503Z
C15	Cer, .05μF, +80-20%, 25V	1005-0014	Erie	5835-505-Y5U0-503Z
C16	Cer, .01μF, +80-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C17	Mica, 470pF, ±5%, 500V	1002-0035	Elmenco	DM15-F-471J
C18	Cer, .05μF, +80-20%, 25V	1005-0014	Erie	5835-505-Y5U0-503Z
C19	Mica, 470pF, ±5%, 500V	1002-0035	Elmenco	DM15-F-471J
C20	Not Used			
C21	Cer, .05μF, +80-20%, 25V	1005-0014	Erie	5835-505-Y5U0-503Z
C22	Elect, 100μF, ±10%, 25V	1013-0003	Sprague	30D107G025DD5
C23	Mica, 100pF, ±5%, 500V	1002-0011	Elmenco	DM15-F-101J
C24	Mica, 470pF, ±5%, 500V	1002-0035	Elmenco	DM15-F-471J
C25	Poly, .027μF, ±10%, 100V	1008-0032	Sprague	225P27391
C26	Poly, .027μF, ±10%, 100V	1008-0032	Sprague	225P27391
C27	Mica, 2000pF, ±5%, 500V	1002-0077	Elmenco	DM19-E-202J
C28	Poly, .027μF, ±10%, 100V	1008-0032	Sprague	225P27391
C29	Poly, .027μF, ±10%, 100V	1008-0032	Sprague	225P27391
C30	Mica, 470pF, ±1%, 500V	1002-0044	Elmenco	DM15-F-471F
C31	Cer, .05μF, +80-20%, 25V	1005-0014	Erie	5835-505-Y5U0-503Z
C32	Elect, 15μF, ±10%, 25V	1013-0005	Sprague	30D156G025BB5
C33	Cer, .01μF, +80-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C34	Cer, .01μF, +80-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C35	Cer, .05μF, +80-20%, 25V	1005-0014	Erie	5835-505-Y5U0-503Z
	COILS			
L1	RF Choke, 470μH, ±5%	1585-0019	Delevan	2500-12
L2	RF Choke, 470μH, ±5%	1585-0019	Delevan	2500-12
L3	Var. Inductor, 8 turns, 16 MHz	1596-0111	TRW	21024
L4	Var. Inductor, 8 turns, 16 MHz	1596-0111	TRW	21024
L5	RF Choke, 82μH, ±5%	1585-0032	Delevan	1537-72
L6	RF Choke, 82μH, ±5%	1585-0032	Delevan	1537-72
L7	RF Choke, 2.2mH, ±5%	1585-0030	Delevan	2500-44
L8	RF Choke, 4.7mH, ±5%	1585-0006	Delevan	2500-60
L9	RF Choke, 4.7mH, ±5%	1585-0006	Delevan	2500-60
L10	RF Choke, 2.2mH, ±5%	1585-0030	Delevan	2500-44
L11	RF Choke, 22mH, ±15%	1585-0029	Delevan	2534-56
L12	RF Choke, 22mH, ±15%	1585-0029	Delevan	2534-56

SECOND IF AND DISCRIMINATOR (CH-A2) (cont.)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
	DIODES			
CR1	Ge, G633	1282-0005	ITT	G633
CR2	Ge, G633	1282-0005	ITT	G633
CR3	Ge, G633	1282-0005	ITT	G633
CR4	Si, 1N3064	1281-0013	Teledyne	1N3064
CR5	Si, 1N3064	1281-0013	Teledyne	1N3064
CR6	Si, 1N3064	1281-0013	Teledyne	1N3064
CR7	Si, 1N3064	1281-0013	Teledyne	1N3064
CR8	Ge, G633	1282-0005	ITT	G633
CR9	Si, 1N3064	1281-0013	Teledyne	1N3064
CR10	Si, 1N3064	1281-0013	Teledyne	1N3064
	INTEGRATED CIRCUITS			
IC1	RF Ampl, CA3028A	2025-0012	RCA	CA3028A
IC2	RF Ampl, CA3028A	2025-0012	RCA	CA3028A
	RESISTORS			
R1	Comp, 3.9kΩ, ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
R2	Comp, 3.9kΩ, ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
R3	Comp, 3.3kΩ, ±5%, 1/4W	1066-3325	Allen-Bradley	CB3325
R4	Comp, 1.2kΩ, ±5%, 1/4W	1066-1225	Allen-Bradley	CB1225
R5	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R6	Comp, 51Ω, ±5%, 1/4W	1066-5105	Allen-Bradley	CB5105
R7	Comp, 220Ω, ±5%, 1/4W	1066-2215	Allen-Bradley	CB2215
R8	Comp, 1kΩ, ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R9	Comp, 3.9kΩ, ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
R10	Comp, 1kΩ, ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R11	Comp, 4.7kΩ, ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
R12	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R13	Comp, 22Ω, ±5%, 1/4W	1066-2205	Allen-Bradley	CB2205
R14	Comp, 3.9kΩ, ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
R15	Comp, 1.5kΩ, ±5%, 1/4W	1066-1525	Allen-Bradley	CB1525
R16	Comp, 1kΩ, ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R17	Comp, 1.2kΩ, ±5%, 1/4W	1066-1225	Allen-Bradley	CB1225
R18	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R19	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R20	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R21	Comp, 820Ω, ±5%, 1/2W	1067-8215	Allen-Bradley	EB8215
R22	Comp, 12kΩ, ±5%, 1/4W	1066-1235	Allen-Bradley	CB1235
R23	Comp, 3.3kΩ, ±5%, 1/4W	1066-3325	Allen-Bradley	CB3325
R24	Comp, 3.3kΩ, ±5%, 1/4W	1066-3325	Allen-Bradley	CB3325
R25	Comp, 22Ω, ±5%, 1/4W	1066-2205	Allen-Bradley	CB2205
R26	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R27	Comp, 560Ω, ±5%, 1/4W	1066-5615	Allen-Bradley	CB5615
R28	Comp, 68Ω, ±5%, 1/4W	1066-6805	Allen-Bradley	CB6805
R29	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R30	M Film, 2.21kΩ, ±1%, 1/8W	1075-0010	Dale	MFF1/8T1
R31	M Film, 10kΩ, ±1%, 1/8W	1075-0009	Dale	MFF1/8T1
R32	Comp, 3.3kΩ, ±5%, 1/4W	1066-3325	Allen-Bradley	CB3325
R33	M Film, 332Ω, ±1%, 1/8W	1075-0024	Dale	MFF1/8T1
R34	M Film, 2.21kΩ, ±1%, 1/8W	1075-0010	Dale	MFF1/8T1
R35	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R36	Comp, 12kΩ, ±5%, 1/4W	1066-1235	Allen-Bradley	CB1235
R37	Not Used			
R38	M Film, 1kΩ, ±1%, 1/2W	1076-0007	Dale	MFF1/2T1
R39	M Film, 357Ω, ±1%, 1/2W	1076-0012	Dale	MFF1/2T1
R40	Comp, 1kΩ, ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025

SECOND IF AND DISCRIMINATOR (CH-A2) (cont.)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R41	Comp, 470Ω, ±5%, 1/4W	1066-4715	Allen-Bradley	CB4715
R42	M Film, 475Ω, ±1%, 1/8W	1075-0023	Dale	MFF 1/8 T1
R43	M Film, 14.7Ω, ±1%, 1/4W	1077-0002	Dale	MFF 1/4 T1
R44	Comp, 4.7kΩ, ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
R45	Comp, 33kΩ, ±5%, 1/4W	1066-3335	Allen-Bradley	CB3335
R46	M Film, 1kΩ, ±1%, 1/2W	1076-0007	Dale	MFF 1/2 T1
R47	M Film, 274Ω, ±1%, 1/2W	1076-0013	Dale	MFF 1/2 T1
R48	Comp, 1.2kΩ, ±5%, 1/2W	1067-1225	Allen-Bradley	EB1225
R49	Pot, 200Ω, ±10%, 1/4W	1200-0016	Allen-Bradley	F FR201U
	TRANSISTORS			
Q1	Si, PNP, TIS 37	1271-0003	T.I.	TIS 37
Q2	Si, NPN, 2N3565	1272-0017	Fairchild	2N3565
Q3	Si, NPN, 2N3565	1272-0017	Fairchild	2N3565
Q4	Si, NPN, 2N3567	1272-0014	Fairchild	2N3567
Q5	Si, NPN, 2N3565	1272-0017	Fairchild	2N3565
Q6	Si, NPN, 2N4275	1272-0016	Fairchild	2N4275
Q7	Si, NPN, 2N3565	1272-0017	Fairchild	2N3565
Q8	Si, NPN, 2N4275	1272-0016	Fairchild	2N4275
Q9	Si, NPN, 2N3565	1272-0017	Fairchild	2N3565
Q10	Si, NPN, 2N4275	1272-0016	Fairchild	2N4275



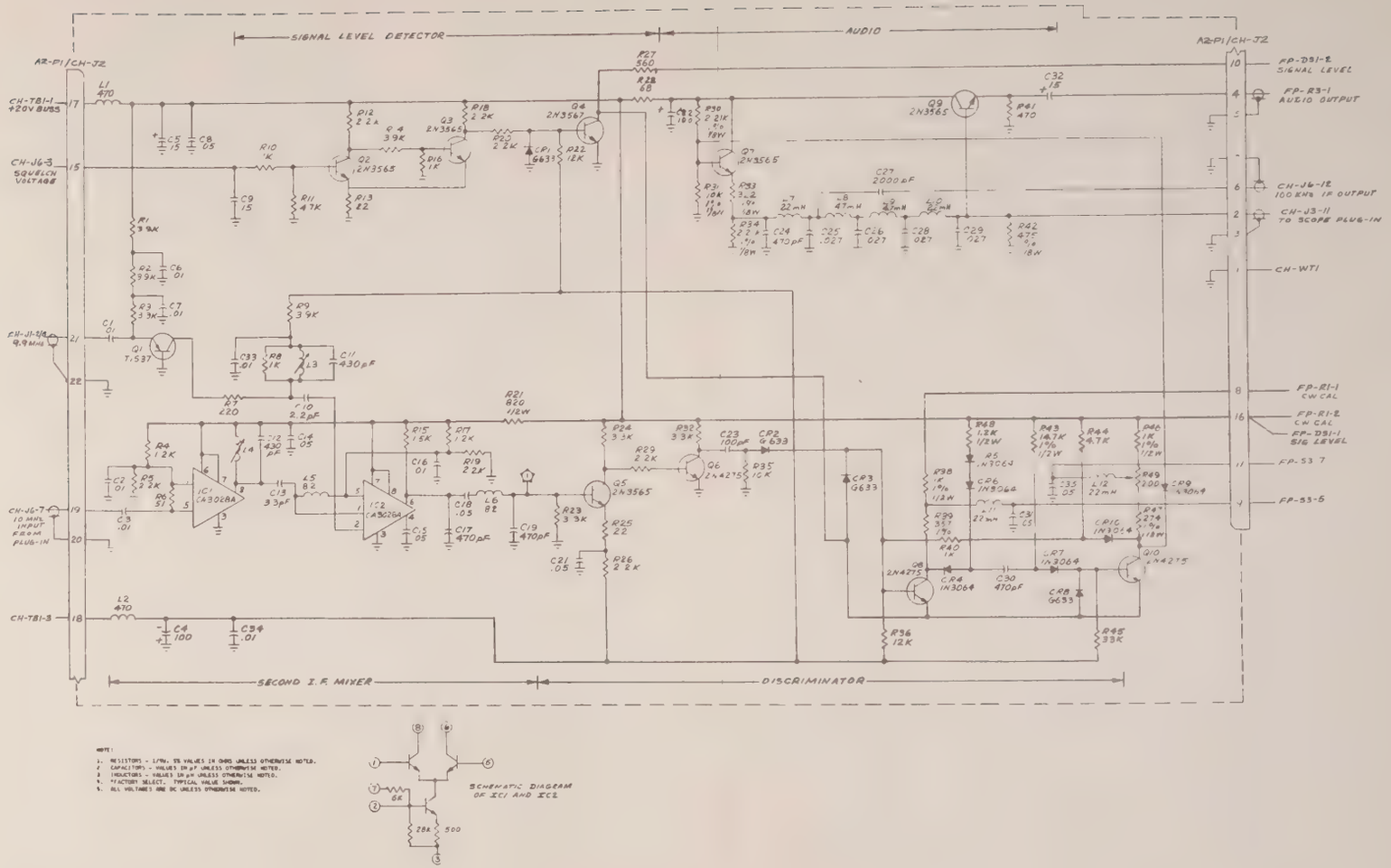


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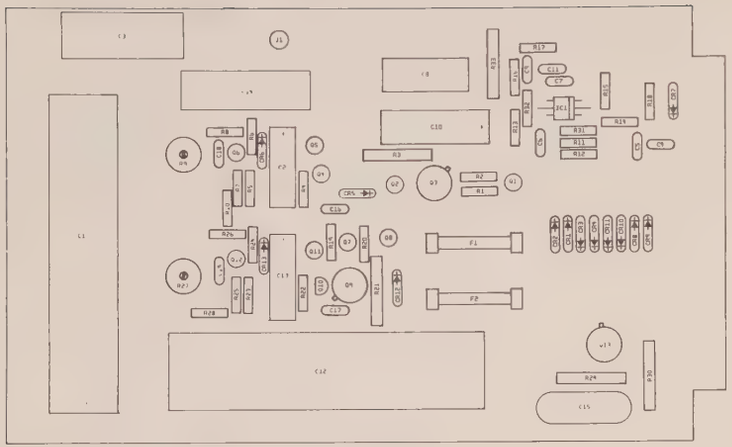
Figure 6-1. Second IF and Disriminator. (CH-A2)

POWER SUPPLY (CH-A5)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
CH-A5	Board Assembly, Power Supply	7001-0030	Cushman	
	Board, Printed Circuit	1780-0100	Cushman	
	CAPACITORS			
C1	Elec, 2300μF, 50V	1014-0004	Sprague	39D-238G050JT5
C2	Elec, 100μF, +75-10%, 12V	1013-0011	Sprague	30D107G012CC5
C3	Elec, 500μF, 25V	1014-0002	Ill. Elna	25T500
C4	Cer, .05μF, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C5	Cer, .1μF, ±10%, 100V	1005-0064	Aerovox	CK06BX104K
C6	Cer, .1μF, ±10%, 100V	1005-0064	Aerovox	CK06BX104K
C7	Mica, 470pF, ±5%, 100V	1002-0035	Elmenco	DM15-F-471J
C8	Elec, 100μF, ±10%, 25V	1013-0003	Sprague	30D107G025DD5
C9	Cer, .1μF, ±10%, 100V	1005-0064	Aerovox	CK06BX104K
C10	Elec. 250μF, 16V	1013-0016	Sprague	30D257G016DF2
C11	Cer, .1μF, ±10%, 100V	1005-0064	Aerovox	CK06BX104K
C12	Elec, 2300μF, 50V	1014-0004	Sprague	39D-238G050JT5
C13	Elec, 100μF, +75-10%, 12V	1013-0011	Sprague	30D107G012CC5
C14	Elec, 500μF, 25V	1014-0002	Ill. Elna	25T500
C15	Cer, .22μF, ±10%, 400V	1008-0042	Sprague	225P22494YA3
C16	Cer, .002μF, ±20%, 500V	1005-0003	Erie	831-596-Z5U-202M
C17	Cer, .002μF, +20%, 500V	1005-0003	Erie	831-596-Z5U-202M
C18	Cer, .01μF, +80-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C19	Cer, .01μF, +80-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
	CONNECTORS			
J1	Phone Jack, P.C. Bd Mount	2586-0007	Keystone	572
	DIODES			
CR1	Si, 1N4002	1281-0023	ITT	1N4002
CR2	Si, 1N4002	1281-0023	ITT	1N4002
CR3	Si, 1N4002	1281-0023	ITT	1N4002
CR4	Si, 1N4002	1281-0023	ITT	1N4002
CR5	Si, 1N4002	1281-0023	ITT	1N4002
CR6	Zener, 1N957, 6.8V	1281-0007	Motorola	1N957
CR7	Zener, 1N4733	1281-0015	Motorola	1N4733
CR8	Si, 1N4002	1281-0023	ITT	1N4002
CR9	Si, 1N4002	1281-0023	ITT	1N4002
CR10	Si, 1N4002	1281-0023	ITT	1N4002
CR11	Si, 1N4002	1281-0023	ITT	1N4002
CR12	Si, 1N4002	1281-0023	ITT	1N4002
CR13	Zener, 1N957, 6.8V	1281-0007	Motorola	1N957
	FUSES			
F1	1.0 Amp, Slo Blo	1955-0006	Littelfuse	313001
F2	1.0 Amp, Slo Blo	1955-0006	Littelfuse	313001
	INTEGRATED CIRCUIT			
IC1	Op Amp MFC6070	2025-0060	Motorola	MFC6070
	RESISTORS			
R1	Comp, 1.8KΩ, ±5%, 1/4W	1066-1825	Allen-Bradley	CB1825
R2	Comp, 100Ω, ±5%, 1/4W	1066-1015	Allen-Bradley	CB1015
R3	WW 1.0Ω, ±3%, 3W	1159-0001	Ohmite	4330
R4	Comp, 470Ω, ±5%, 1/4W	1066-4715	Allen-Bradley	CB4715
R5	Comp, 680Ω, ±5%, 1/4W	1066-6815	Allen-Bradley	CB6815

POWER SUPPLY (CH-A5) (cont.)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R6	Comp, 4.7kΩ, ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
R7	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R8	Comp, 390Ω, ±5%, 1/4W	1066-3915	Allen-Bradley	CB3915
R9	Pot, 500Ω, ±20%, 1/4W	1200-0020	Allen-Bradley	FR501M
R10	Comp, 1kΩ, ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R11	Comp, 1MΩ, ±5%, 1/4W	1066-1055	Allen-Bradley	CB1055
R12	Comp, 180kΩ, ±5%, 1/4W	1066-1845	Allen-Bradley	CB1845
R13	Comp, 1MΩ, ±5%, 1/4W	1066-1055	Allen-Bradley	CB1055
R14	Comp, 56kΩ, ±5%, 1/4W	1066-5635	Allen-Bradley	CB5635
R15	Comp, 820kΩ, ±5%, 1/4W	1066-8245	Allen-Bradley	CB9245
R16	Comp, 6.8kΩ, ±5%, 1/4W	1066-6825	Allen-Bradley	CB6825
R17	Comp, 6.8kΩ, ±5%, 1/4W	1066-6825	Allen-Bradley	CB6825
R18	Comp, 680Ω, ±5%, 1/2W	1067-6815	Allen-Bradley	EB6815
R19	Comp, 1.8kΩ, ±5%, 1/4W	1066-1825	Allen-Bradley	CB1825
R20	Comp, 100Ω, ±5%, 1/4W	1066-1015	Allen-Bradley	CB1015
R21	WW, 1.0Ω, ±3%, 3W	1159-0001	Ohmite	4330
R22	Comp, 470Ω, ±5%, 1/4W	1066-4715	Allen-Bradley	CB4715
R23	Comp, 270Ω, ±5%, 1/4W	1066-2715	Allen-Bradley	CB2715
R24	Comp, 4.7kΩ, ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
R25	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R26	Comp, 470Ω, ±5%, 1/4W	1066-4715	Allen-Bradley	CB4715
R27	Pot, 500Ω, ±20%, 1/4W	1200-0020	Allen-Bradley	FR501M
R28	Comp, 470Ω, ±5%, 1/4W	1066-4715	Allen-Bradley	CB4715
R29	Comp, 2.7kΩ, ±5%, 1W	1068-2725	Allen-Bradley	GB2725
R30	Comp, 33kΩ, ±5%, 1W	1068-3335	Allen-Bradley	GB3335
R31	Comp, 2MΩ, ±5%, 1/4W	1066-2055	Allen-Bradley	CB2055
R32	Comp, 10Ω, ±5%, 1/4W	1066-1005	Allen-Bradley	CB1005
R33	Comp. 62Ω, ±5%, 1W	1068-6205	Allen-Bradley	GB6205
	TRANSISTORS			
Q1	Fet, 2N4342	1272-0027	Fairchild	2N4342
Q2	Si, NPN, 2N3567	1272-0014	Fairchild	2N3567
Q3	Si, NPN, 2N3053	1272-0011	RCA	2N3053
Q4	Si, NPN, 2N3565	1272-0017	Fairchild	2N3565
Q5	Si, PNP, 2N4249	1272-0024	Fairchild	2N4249
Q6	Si, PNP, 2N4249	1272-0024	Fairchild	2N4249
Q7	Fet, 2N4342	1272-0027	Fairchild	2N4342
Q8	Si, NPN, 2N3567	1272-0014	Fairchild	2N3567
Q9	Si, NPN, 2N3053	1272-0011	RCA	2N3053
Q10	Si, NPN, 2N3416	1271-0006	GE	2N3416
Q11	Si, PNP, 2N4249	1272-0024	Fairchild	2N4249
Q12	Si, PNP, 2N4249	1272-0024	Fairchild	2N4249
Q13	Triac, 40529	1272-0029	RCA	40529



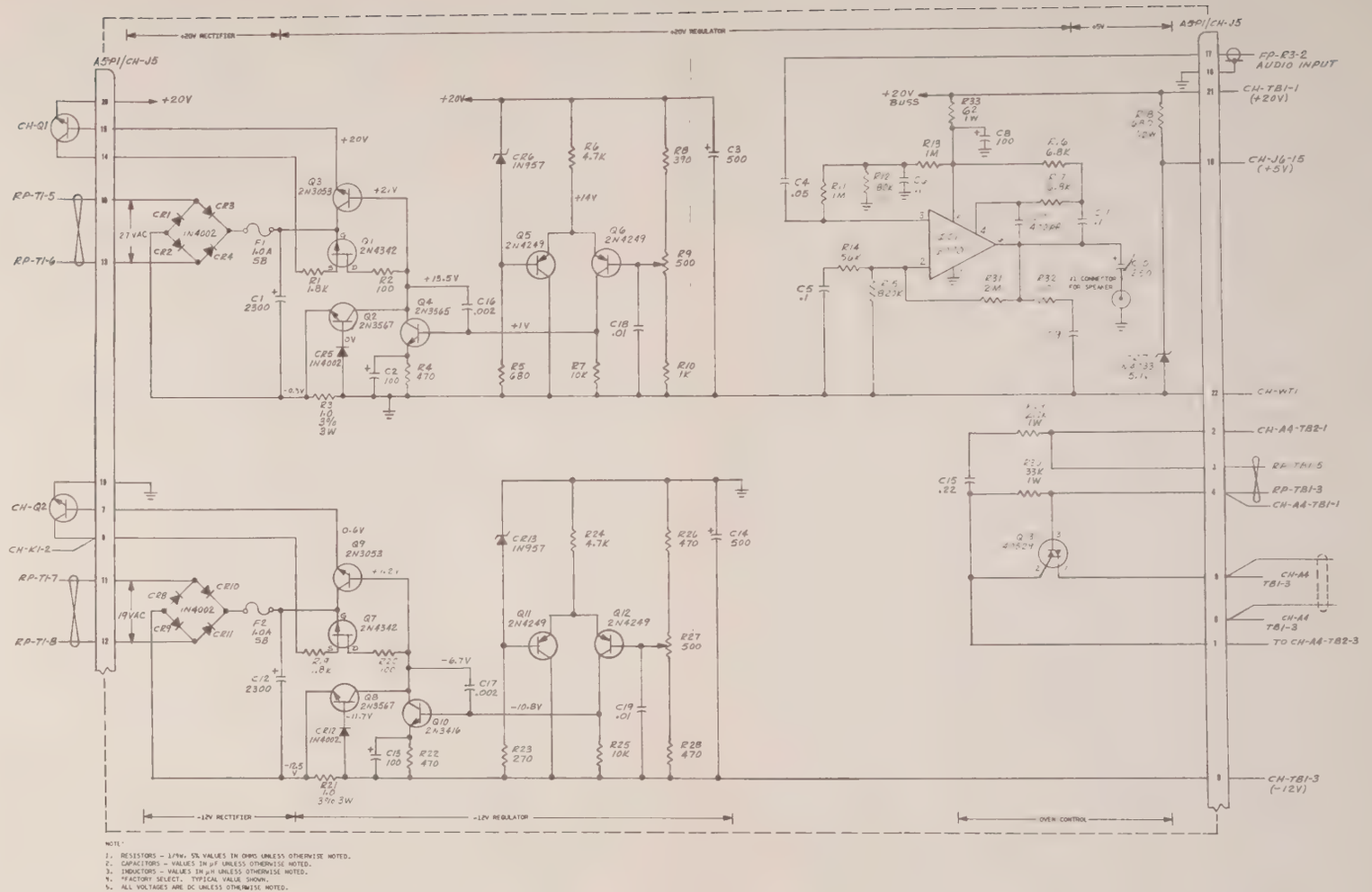


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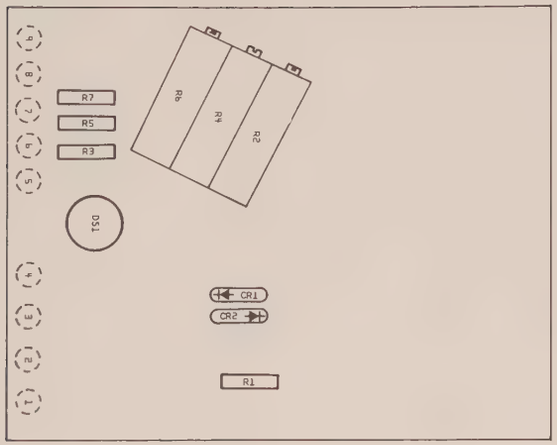
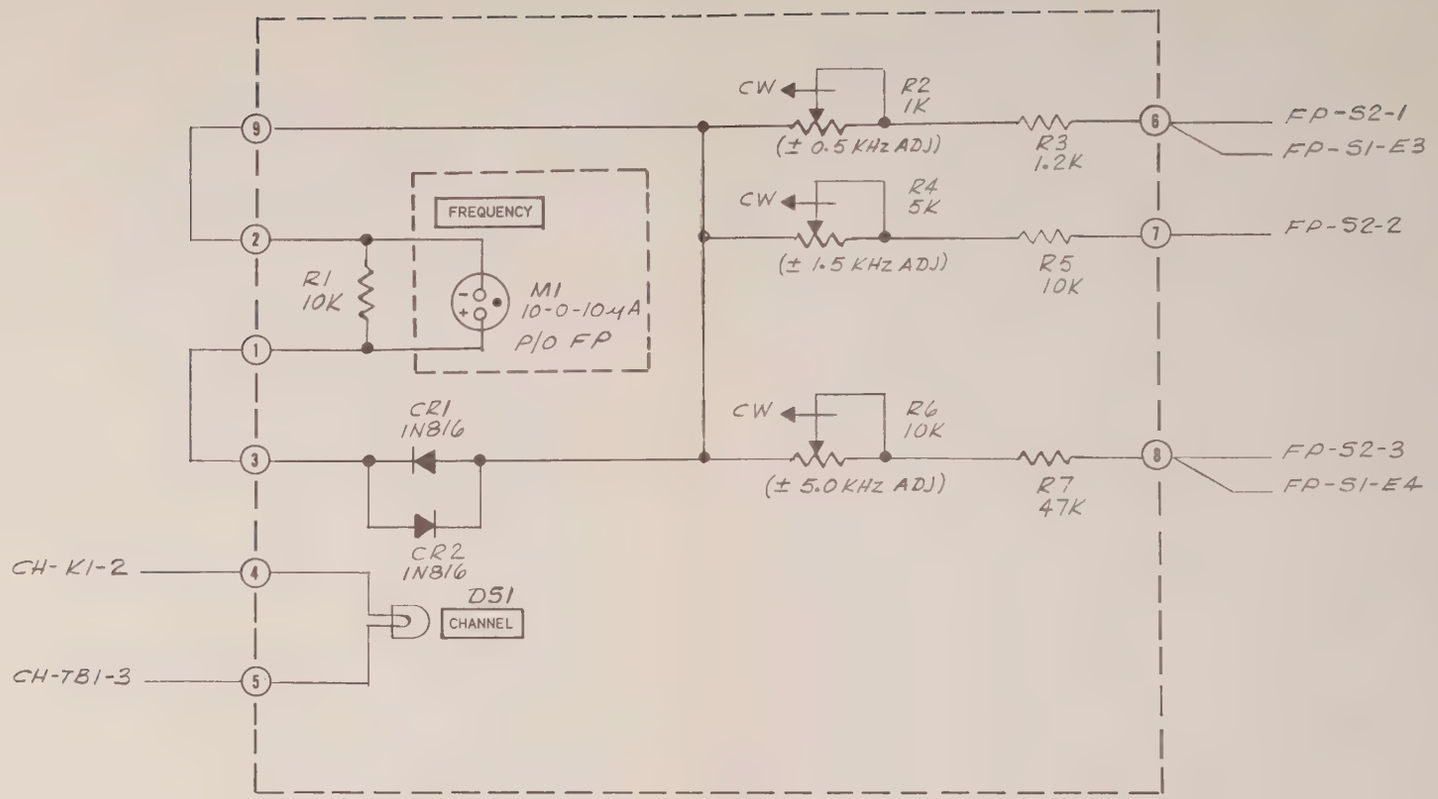
Figure 6-2. Power Supply. (CH-A5)
6-9/6-10

FREQUENCY ERROR METER (FP-A1)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
FP-A1	Board Assembly, Frequency Error Meter	7001-0031	Cushman	
	Board, Printed Circuit	1780-0101	Cushman	
	DIODES			
CR1	Si, 1N816	1281-0009	Sylvania	1N816
CR2	Si, 1N816	1281-0009	Sylvania	1N816
	LAMP			
DS1	Incandescent, 28V T 3 1/4	2870-0012	GE	747
	RESISTORS			
R1	Comp, 10k, ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R2	Pot, WW, 1kΩ, 1/2W	1215-0013	Helitrim	89WR
R3	Comp, 1.2kΩ, ±5%, 1/4W	1066-1225	Allen-Bradley	CB1225
R4	Pot, WW, 5kΩ, 1/2W	1215-0012	Helitrim	89WR
R5	Comp, 10k, ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R6	Pot, WW, 10kΩ, 1/2W	1215-0005	Helitrim	77 PR
R7	Comp, 47kΩ, +5%, 1/4W	1066-4735	Allen-Bradley	CB4735





NOTE:

1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

Figure 6-3. Frequency Error Meter. (FP-A1)

HARMONIC GENERATOR (FP-A2)

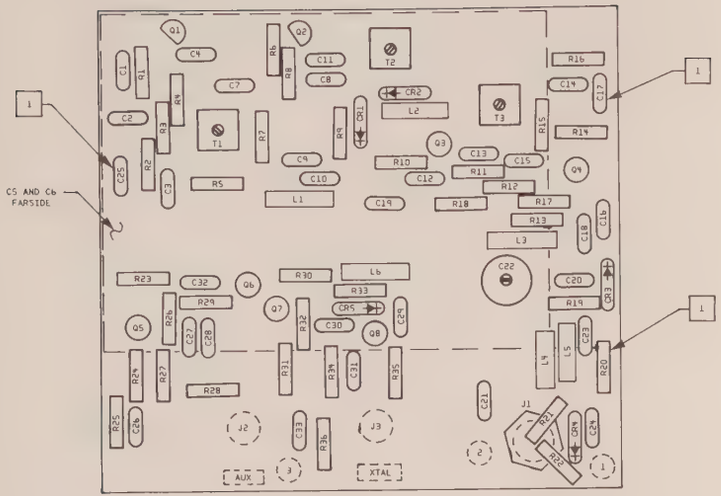
CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
FP-A2	Board Assembly, Harmonic Generator	7001-0032	Cushman	
	Board, Printed Circuit	1780-0102	Cushman	
	CAPACITORS			
C1	Cer, 0.01μF, +80-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C2	Cer, 0.002μF, ±20%, 600V	1005-0003	Erie	831-596-Z5U-202M
C3	Cer, 0.01μF, +80-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C4	Cer, 0.01μF, +80-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C5	Capacitor, Var, 8.1-117.5pF, 3 section, Type B1000-0006 with 180° stop	1000-0006	Cushman	
C6	Cap, Var, P/O C5			
C7	Mica, 100pF, ±5%, 500V	1002-0011	Elmenco	DM15-F-101J
C8	Cer, 0.002μF, +20%, 600V	1005-0003	Erie	831-596-Z5U-202M
C9	Cer, 0.002μF, +20%, 600V	1005-0003	Erie	831-596-Z5U-202M
C10	Cer, 0.01μF, +80-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C11	Cer, 0.002μF, ±20%, 600V	1005-0003	Erie	831-596-Z5U-202M
C12	Mica, 180pF, ±5%, 500V	1002-0005	Elmenco	DM15-F-181J
C13	Cer, 0.002μF, ±20%, 600V	1005-0003	Erie	831-596-Z5U-202M
C14	Cer, 0.002μF, ±20%, 600V	1005-0003	Erie	831-596-Z5U-202M
C15	Cer, 0.002μF, ±20%, 600V	1005-0003	Erie	831-596-Z5U-202M
C16	Mica, 270pF, ±5%, 500V	1002-0031	Elmenco	DM15-F-271J
C17	Mica, 30pF, ±5%, 500V	1002-0043	Elmenco	DM15-E-300J
C18	Cer, 0.002μF, ±20%, 600V	1005-0003	Erie	831-596-Z5U-202M
C19	Cer, 0.002μF, ±20%, 600V	1005-0003	Erie	831-596-Z5U-202M
C20	Mica, 82pF, ±5%, 500V	1002-0020	Elmenco	DM15-E-820J
C21	Cer, 0.002pF, ±20%, 600V	1005-0003	Erie	831-596-Z5U-202M
C22	Cer, Var, 9-35pF	1001-0006	Erie	538-002-94D
C23	Cer, 0.002μF, ±20%, 600V	1005-0003	Erie	831-596-Z5U-202M
C24	Cer, 0.002μF, ±20%, 600V	1005-0003	Erie	831-596-Z5U-202M
C25	Mica, 100pF, ±5%, 500V	1002-0011	Elmenco	DM15-F-101J
C26	Cer, 0.01μF, +80-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C27	Cer, 0.01μF, +80-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C28	Cer, 0.01μF, +80-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C29	Cer, 0.01μF, +80-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C30	Mica, 180pF, ±5%, 500V	1002-0005	Elmenco	DM15-F-181J
C31	Mica, 180pF, ±5%, 500V	1002-0005	Elmenco	DM15-F-181J
C32	Cer, 0.05μF, +80-20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C33	Cer, 0.05μF, +80-20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
	CONNECTOR			
J1	Female, KC 79-35	2536-0010	King	KC79-35
	DIODES			
CR1	Si, 2800	1283-0001	HPA	5082-2800
CR2	Si, 2800	1283-0001	HPA	5082-2800
CR3	Ge, G633	1282-0005	ITT	G633
CR4	Si, 0136	1282-0006	HPA	HPA0136
CR5	Si, Zener, 6.8V, 1N957	1281-0007	Motorola	1N957

HARMONIC GENERATOR (FP-A2) (cont.)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
	INDUCTORS			
L1	Choke, RF, 12μH, ±10%	1585-0011	Delevan	1537-38
L2	Choke, RF, 5.6μH, ±10%	1585-0028	Delevan	1537-30
L3	Choke, RF, 3.9μH, ±5%	1585-0014	Delevan	1537-26
L4	Choke, RF, 5.6μH, ±10%	1585-0028	Delevan	1537-30
L5	Choke, RF, 0.1μH, ±5%	1585-0041	Delevan	2307-101
L6	Choke, RF, 82μH, ±5%	1585-0032	Delevan	1537-72
	JACKS			
J2	PC Board, mounted, phone	2586-0007	Keystone	572
J3	PC Board, mounted, phone	2586-0007	Keystone	572
	RESISTORS			
R1	Comp, 100Ω, ±5%, 1/4W	1066-1015	Allen-Bradley	CB1015
R2	Comp, 2.7Ω, ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R3	Comp, 22kΩ, ±5%, 1/4W	1066-2235	Allen-Bradley	CB2235
R4	Comp, 22kΩ, ±5%, 1/4W	1066-2235	Allen-Bradley	CB2235
R5	Comp, 10Ω, ±5%, 1/4W	1066-1005	Allen-Bradley	CB1005
R6	Comp, 100Ω, ±5%, 1/4W	1066-1015	Allen-Bradley	CB1015
R7	Comp, 2.7kΩ, ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R8	Comp, 22kΩ, ±5%, 1/4W	1066-2235	Allen-Bradley	CB2235
R9	Comp, 22kΩ, ±5%, 1/4W	1066-2235	Allen-Bradley	CB2235
R10	Comp, 1.8kΩ, ±5%, 1/4W	1066-1825	Allen-Bradley	CB1825
R11	Comp, 2.7kΩ, ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R12	Comp, 560Ω, ±5%, 1/4W	1066-5615	Allen-Bradley	CB5615
R13	Comp, 3.3kΩ, ±5%, 1/4W	1066-3325	Allen-Bradley	CB3325
R14	Comp, 10Ω, ±5%, 1/4W	1066-1005	Allen-Bradley	CB1005
R15	Comp, 820Ω, ±5%, 1/4W	1066-8215	Allen-Bradley	CB8215
R16	Comp, 330Ω, ±5%, 1/4W	1066-3315	Allen-Bradley	CB3315
R17	Comp, 68Ω, ±5%, 1/2W	1067-6805	Allen-Bradley	EB6805
R18	Comp, 82Ω, ±5%, 1/2W	1067-8205	Allen-Bradley	EB8205
R19	Comp, 1kΩ, ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R20	Comp, 27kΩ, ±5%, 1/4W	1066-2735	Allen-Bradley	CB2735
R21	Comp, 100Ω, ±5%, 1/4W	1066-1015	Allen-Bradley	CB1015
R22	Comp, 100Ω, ±5%, 1/4W	1066-1015	Allen-Bradley	CB1015
R23	Comp, 560Ω, ±5%, 1/4W	1066-5615	Allen-Bradley	CB5615
R24	Comp, 68Ω, ±5%, 1/4W	1066-6805	Allen-Bradley	CB6805
R25	Comp, 1kΩ, ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R26	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R27	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R28	Comp, 51Ω, ±5%, 1/4W	1066-5105	Allen-Bradley	CB5105
R29	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R30	Comp, 1.2kΩ, ±5%, 1/4W	1066-1225	Allen-Bradley	CB1225
R31	Comp, 270Ω, ±5%, 1/4W	1066-2715	Allen-Bradley	CB2715
R32	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R33	Comp, 1.5kΩ, ±5%, 1/4W	1066-1525	Allen-Bradley	CB1525
R34	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R35	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R36	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
	TRANSFORMERS			
T1	RF, Tunable, 1.0μH	7050-0125	Cushman	
T2	RF, Tunable, 1.0μH	7050-0126	Cushman	
T3	RF, Tuneable, 0.25μH	7050-0127	Cushman	

HARMONIC GENERATOR (FP-A2) (cont.)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
	TRANSISTORS			
Q1	Si, PNP, TIS37	1271-0003	T.I.	TIS37
Q2	Si, PNP, TIS37	1271-0003	T.I.	TIS37
Q3	Si, NPN, 2N3563	1272-0022	Fairchild	2N3563
Q4	Si, NPN, 2N3866	1271-0005	RCA	2N3866
Q5	Si, NPN, 2N3563	1272-0022	Fairchild	2N3563
Q6	Si, NPN, 2N3642	1272-0018	Fairchild	2N3642
Q7	Si, NPN, 2N3563	1272-0022	Fairchild	2N3563
Q8	Si, NPN, 2N3563	1272-0022	Fairchild	2N3563



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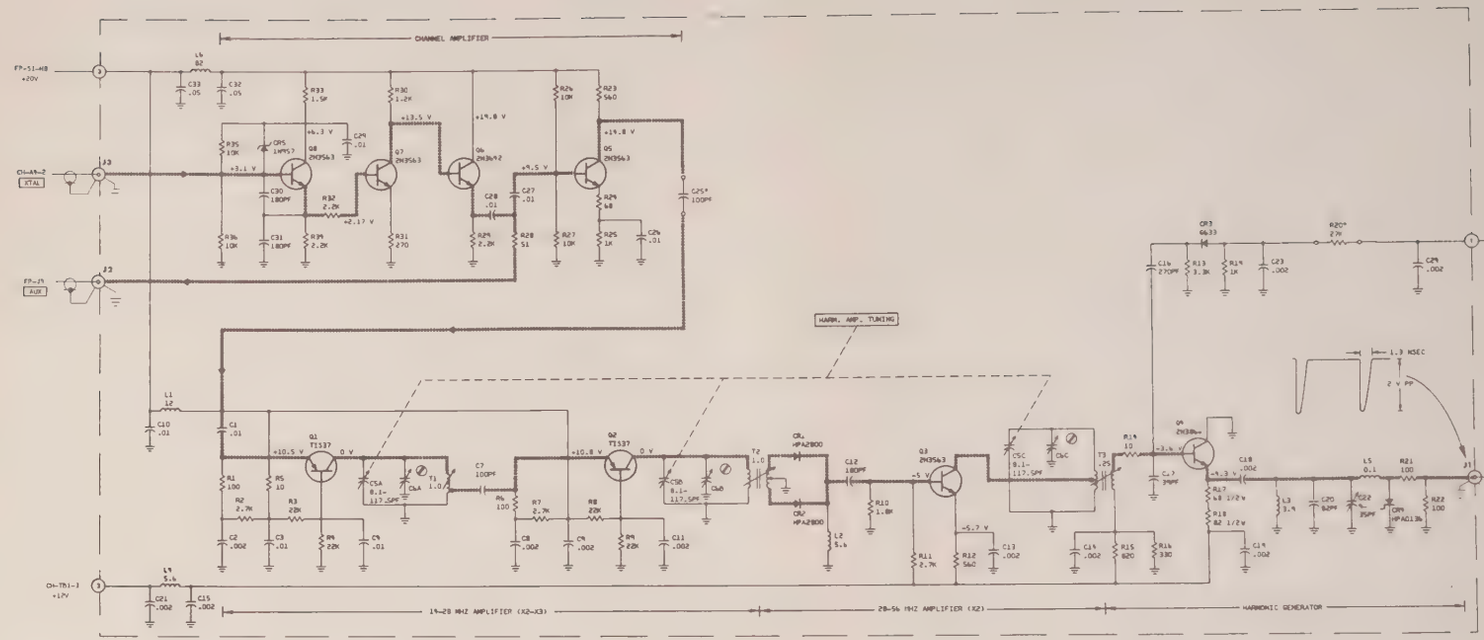

NOTE:

1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN UF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN UH UNLESS OTHERWISE NOTED.
4. * FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGE READINGS ARE DC UNLESS OTHERWISE NOTED.
6. TRIMMER CAPACITORS C5A, B, AND C ARE THE ADJUSTMENTS FOR C5A, B AND C, AND ARE PART OF C5.

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Figure 6-4. Harmonic Generator. (FP-A2)

MULTI-OSCILLATOR (CH-A1)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
CH-A1	Board Assembly, Multi-Oscillator	7001-0033	Cushman	
	Board, Printed Circuit	1780-0103	Cushman	
	CAPACITORS			
C1	Cer, 0.01μF, +80-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C2	Cer, 0.05μF, +80-20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C3	Cer, 0.05μF, +80-20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C4	Mica, 1000pF, 100V	1002-0015	Elmenco	DM15-F-102J
C5	Mica, 470pF, ±5%, 100V	1002-0035	Elmenco	DM15-F-471J
C6	Mica, 220pF, ±5%, 100V	1002-0029	Elmenco	DM15-F-221J
C7	Mica, 39pF, ±5%, 100V	1002-0018	Elmenco	DM15-E-390J
C8	Mica, 1000pF, 100V	1002-0015	Elmenco	DM15-F-102J
C9	Cer, 0.01μF, +80-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C10	Not Used			
C11	Poly, 0.082μF, ±10%, 100V	1008-0023	Sprague	225P82391WA3
C12	Poly, 0.27μF, ±10%, 100V	1008-0028	Sprague	225P27491YA-1
C13	Elect, 15μF, 10%, 25V	1013-0005	Sprague	30D156G025BB5
C14	Poly, 0.1μF, ±10%, 100V	1008-0031	Sprague	225P10491
C15	Elect, 1.0μF, 10%, 100V	1008-0033	TRW	X663F
C16	Cer, 0.01μF, +80-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C17	Cer, 0.01μF, +80-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C18	Poly, 0.027μF, ±10%, 100V	1008-0032	Sprague	225P27391
C19	Elect, 1.0μF, 25V	1013-0004	Sprague	30D105G025BA5
C20	Mica, 180pF, ±5%, 100V	1002-0005	Elmenco	DM15-F-181J
C21	Mica, 180pF, ±5%, 100V	1002-0005	Elmenco	DM15-F-181J
C22	Elect, 1.0μF, 25V	1013-0004	Sprague	30D105G025BA5
C23	Elect, 15μF, 25V	1013-0005	Sprague	30D156G025BB5
C24	Cer, 0.01μF, +80-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C25	Cer, 0.05μF, +80-20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C26	Cer, 22pF, ±2%, 600V, N750	1005-0007	Erie	301-000-C0H0-689C
C27	Cer, 0.05μF, +80-20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C28	Mica, 22pF, ±5%, 100V	1002-0023	Elmenco	DM15-C-220J
C29	Mica, 470pF, ±5%, 100V	1002-0035	Elmenco	DM15-F-471J
C30	Mica, 470pF, ±5%, 100V	1002-0035	Elmenco	DM15-F-471J
C31	Mica, 10pF, ±5%, 100V	1002-0016	Elmenco	D15-C-100J
C32	Cer, 0.01μF, +80-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C33	Cer, 0.01μF, +80-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C34	Mica, 27pF, ±5%, 100V	1002-0008	Elmenco	DM15-E-270J
C35	Mica, 390pF, ±5%, 100V	1002-0033	Elmenco	DM15-F-391J
C36	Cer, 0.01μF, +80-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C37	Cer, 0.01μF, +80-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C38	Cer, 0.05μF, +80-20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C39	Cer, 0.05μF, +80-20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C40	Cer, 0.01μF, +80-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C41	Cer, 0.01μF, +80-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C42	Cer, 0.05μF, +80-20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C43	Cer, 0.05μF, +80-20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C44	Cer, 0.05μF, +80-20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C45	Cer, 0.05μF, +80-20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C46	Cer, 0.01μF, +80-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C47	Mica, 470pF, ±5%, 100V	1002-0035	Elmenco	DM15-F-471J
C48	Poly, 0.0022μF, 100V	1008-0020	Sprague	225P22291WA3
C49	Mica, 1000pF, ±5%, 100V	1002-0015	Elmenco	DM15-F-102J
C50	Cer, 0.05μF, +80-20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z

MULTI-OSCILLATOR (CH-A1) (cont.)

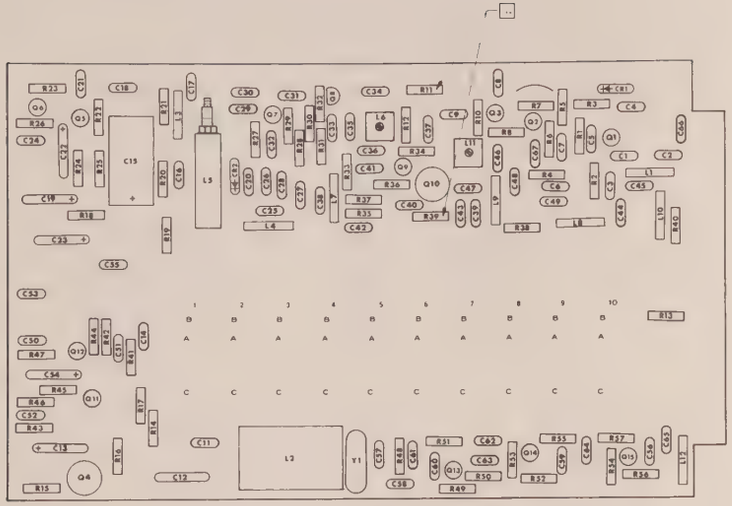
CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
C51	Cer, 0.05μF, +80%-20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C52	Cer, 0.05μF, +80%-20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C53	Mica, 47pF, ±5%, 100V	1002-0012	Elmenco	DM15-E-470J
C54	Elect, 1.0μF, 25V	1013-0004	Sprague	30D105G025BA5-
C55	Cer, 0.05μF, +80%-20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C56	Cer, 0.05μF, +80%-20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C57	Mica, 10pF, ±5%, 100V	1002-0016	Elmenco	D15-C-100J
C58	Mica, 27pF, ±5%, 100V	1002-0008	Elmenco	DM15-E-270J
C59	Cer, 0.05μF, +80%-20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C60	Mica, 470pF, ±5%, 100V	1002-0035	Elmenco	DM15-F-471J
C61	Mica, 220pF, ±5%, 100V	1002-0029	Elmenco	DM15-F-221J
C62	Cer, 0.05μF, +80%-20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C63	Cer, 4.7pF, ±5%, 600V	1005-0015	Erie	301-000-C0H0-479C
C64	Cer, 0.01μF, +80%-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C65	Cer, 0.01μF, +80%-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C66	Mica, 10pF, ±5%, 100V	1002-0016	Elmenco	D15-C-100J
C67	Mica, 5pF, ±5%, 100V	1002-0028	Elmenco	DM15-C-050D
	CLIPS			
	Terminal P.C.	3768-0004	Elco	60-8200-0513
	Guide Pin	3768-0005	Elco	62-5204-4112
	CRYSTAL			
Y1	Xtal, 9.9 MHz	2035-0004	Cushman	
	DIODES			
CR1	Si, Zener, 6.8V, 1N957	1281-0007	Motorola	1N957
CR2	Voltage Variable C, V33	1281-0010	TRW	V33
	INDUCTORS			
L1	Choke, RF, 82μH, ±5%	1585-0032	Delevan	1537-72
L2	Toroid, 0.5μH	1579-0008	Pulse Engr.	6241
L3	Choke, RF, 82μH, ±5%	1585-0032	Delevan	1537-72
L4	Choke, RF, 82μH, ±5%	1585-0032	Delevan	1537-72
L5	Inductor, Var, 3.8-7.3μH	1596-0025	Delevan	4000-18
L6	Inductor, Var, 0.50-0.75μH	1596-0111	TRW	21024
L7	Choke, RF, 82μH, ±5%	1585-0032	Delevan	1537-72
L8	Choke, RF, 82μH, ±5%	1585-0032	Delevan	1537-72
L9	Choke, RF, 82μH, ±5%	1585-0032	Delevan	1537-72
L10	Choke, RF, 82μH, ±5%	1585-0032	Delevan	1537-72
L11	Inductor, Var, 0.50-0.75μH	1596-0111	TRW	21024
L12	Choke, RF, 82μH, ±5%	1585-0032	Delevan	1537-72
	RESISTORS			
R1	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R2	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R3	Comp, 1.5kΩ, ±5%, 1/4W	1066-1525	Allen-Bradley	CB1525
R4	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R5	Comp, 18kΩ, ±5%, 1/4W	1066-1835	Allen-Bradley	CB1835
R6	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R7	Comp, 2.7kΩ, ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R8	Comp, 470Ω, ±5%, 1/4W	1066-4715	Allen-Bradley	CB4715
R9	Not Used			
R10	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225

MULTI-OSCILLATOR (CH-A1) (cont.)

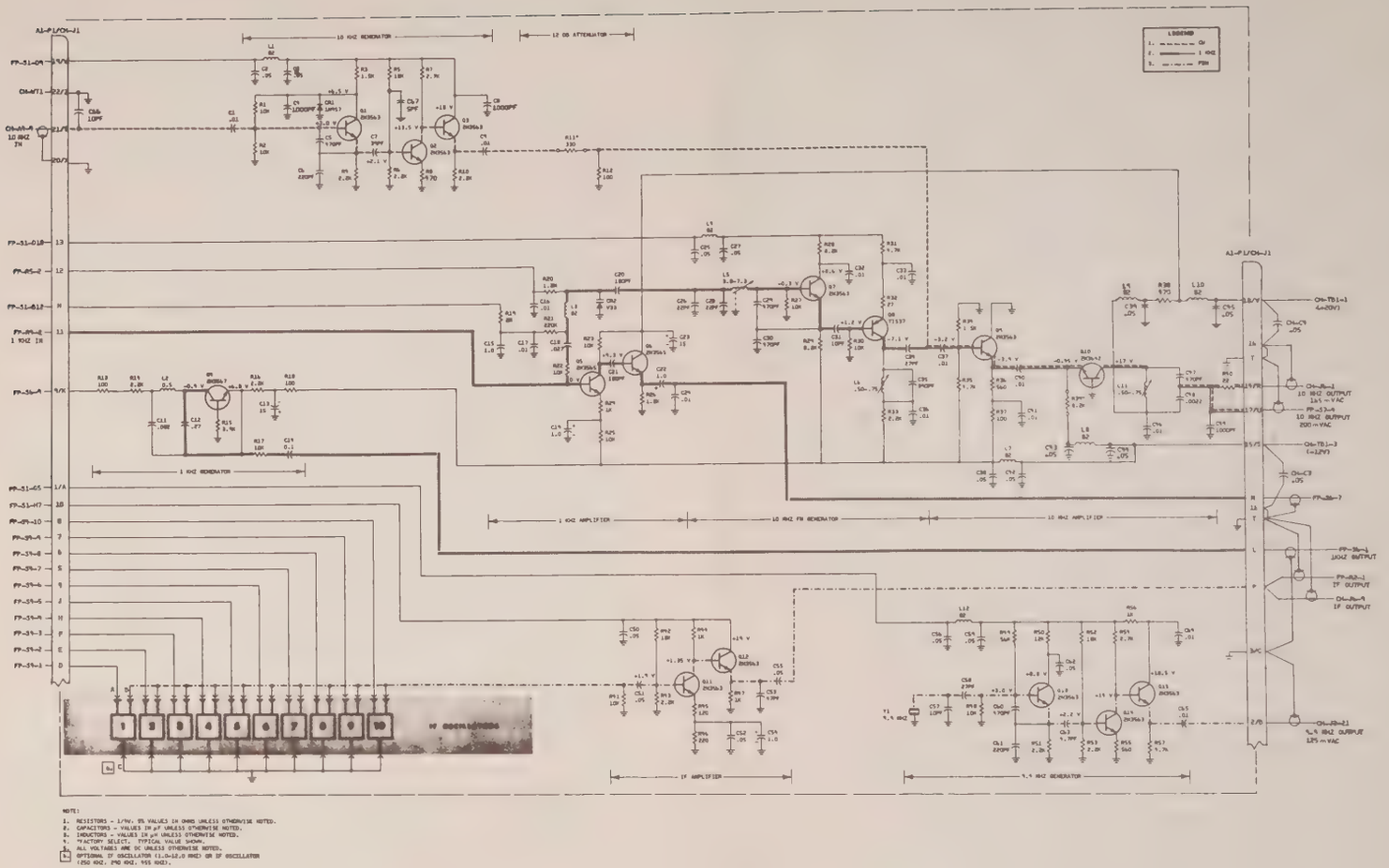
CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
R11	Comp, 330Ω, ±5%, 1/4W	1066-3315	Allen-Bradley	CB3315
R12	Comp, 100Ω, ±5%, 1/4W	1066-1015	Allen-Bradley	CB1015
R13	Comp, 100Ω, ±5%, 1/4W	1066-1015	Allen-Bradley	CB1015
R14	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R15	Comp, 3.9kΩ, ±5%, 1/4W	1066-3925	Allen-Bradley	CB3925
R16	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R17	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R18	Comp, 100Ω, ±5%, 1/4W	1066-1015	Allen-Bradley	CB1015
R19	Comp, 2MΩ, ±5%, 1/4W	1066-2055	Allen-Bradley	CB2055
R20	Comp, 1.2MΩ, ±5%, 1/4W	1066-1255	Allen-Bradley	CB1255
R21	Comp, 220kΩ, ±5%, 1/4W	1066-2245	Allen-Bradley	CB2245
R22	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R23	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R24	Comp, 1kΩ, ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R25	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R26	Comp, 1.8kΩ, ±5%, 1/4W	1066-1825	Allen-Bradley	CB1825
R27	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R28	Comp, 8.2kΩ, ±5%, 1/4W	1066-8225	Allen-Bradley	CB8225
R29	Comp, 8.2kΩ, ±5%, 1/4W	1066-8225	Allen-Bradley	CB8225
R30	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R31	Comp, 4.7kΩ, ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
R32	Comp, 27Ω, ±5%, 1/4W	1066-2705	Allen-Bradley	CB2705
R33	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R34	Comp, 1.5kΩ, ±5%, 1/4W	1066-1525	Allen-Bradley	CB1525
R35	Comp, 4.7kΩ, ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
R36	Comp, 560Ω, ±5%, 1/4W	1066-5615	Allen-Bradley	CB5615
R37	Comp, 100Ω, ±5%, 1/4W	1066-1015	Allen-Bradley	CB1015
R38	Comp, 470Ω, ±5%, 1/4W	1066-4715	Allen-Bradley	CB4715
R39	Comp, 8.2kΩ, ±5%, 1/4W	1066-8225	Allen-Bradley	CB8225
R40	Comp, 22Ω, ±5%, 1/4W	1066-2205	Allen-Bradley	CB2205
R41	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R42	Comp, 18kΩ, ±5%, 1/4W	1066-1835	Allen-Bradley	CB1835
R43	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R44	Comp, 1kΩ, ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R45	Comp, 120Ω, ±5%, 1/4W	1066-1215	Allen-Bradley	CB1215
R46	Comp, 220Ω, ±5%, 1/4W	1066-2215	Allen-Bradley	CB2215
R47	Comp, 1kΩ, ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R48	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R49	Comp, 56kΩ, ±5%, 1/4W	1066-5635	Allen-Bradley	CB5635
R50	Comp, 12kΩ, ±5%, 1/4W	1066-1235	Allen-Bradley	CB1235
R51	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R52	Comp, 18kΩ, ±5%, 1/4W	1066-1835	Allen-Bradley	CB1835
R53	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R54	Comp, 2.7kΩ, ±5%, 1/4W	1066-2725	Allen-Bradley	CB2725
R55	Comp, 560Ω, ±5%, 1/4W	1066-5615	Allen-Bradley	CB5615
R56	Comp, 1kΩ, ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R57	Comp, 4.7kΩ, ±5%, 1/4W	1066-4725	Allen-Bradley	CB4725
	TRANSISTORS			
Q1	Si, NPN, 2N3563	1272-0022	Fairchild	2N3563
Q2	Si, NPN, 2N3563	1272-0022	Fairchild	2N3563
Q3	Si, NPN, 2N3563	1272-0022	Fairchild	2N3563
Q4	Si, NPN, 2N3567	1272-0014	Fairchild	2N3567
Q5	Si, NPN, 2N3565	1272-0017	Fairchild	2N3565

MULTI-OSCILLATOR (CH-A1) (cont.)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
Q6	Si, NPN, 2N3565	1272-0017	Fairchild	2N3565
Q7	Si, NPN, 2N3563	1272-0022	Fairchild	2N3563
Q8	Si, PNP, TIS37	1271-0003	T.I.	TIS37
Q9	Si, NPN, 2N3563	1272-0022	Fairchild	2N3563
Q10	Si, NPN, 2N3642	1272-0018	Fairchild	2N3642
Q11	Si, NPN, 2N3563	1272-0022	Fairchild	2N3563
Q12	Si, NPN, 2N3563	1272-0022	Fairchild	2N3563
Q13	Si, NPN, 2N3563	1272-0022	Fairchild	2N3563
Q14	Si, NPN, 2N3563	1272-0022	Fairchild	2N3563
Q15	Si, NPN, 2N3563	1272-0022	Fairchild	2N3563



1. FACTORY SELECT VALUE.



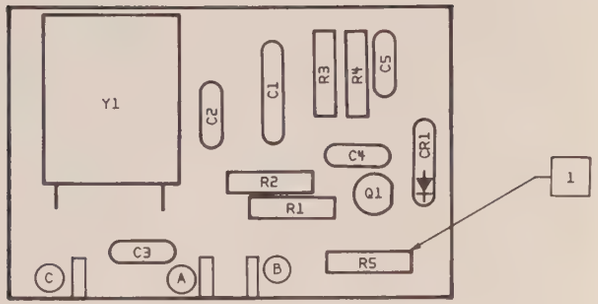
NOTE:
1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN pF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN µH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.
6. OPTIONAL IF OSCILLATOR (1.0-12.0 MHz) OR IF OSCILLATOR (250 KHz, 2MD 4KHz, 955 KHz).

C10 NOT USED
R9 NOT USED

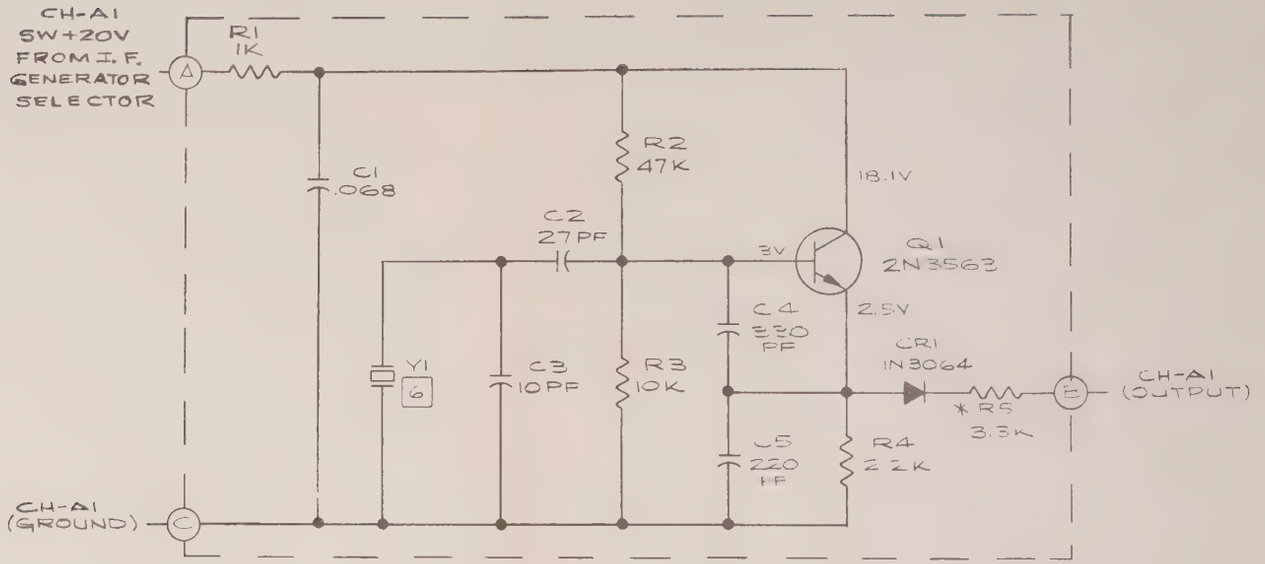
Figure 6-5. Multi-Oscillator. (CH-A1)

IF OSCILLATOR (CH-A6)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
CH-A6	Board Assembly, IF Oscillator	7001-0027	Cushman	
	Board, Printed Circuit	1780-0104	Cushman	
	CAPACITORS			
C1	Poly, 0.068μF, ±10%, 100V	1008-0036	Sprague	225P68391WA3
C2	Mica, 27pF, ±5%, 100V	1002-0008	Elmenco	DM15-E-270J
C3	Mica, 10pF, ±5%, 100V	1002-0016	Elmenco	D15-C-100J
C4	Mica, 330pF, ±5%, 100V	1002-0032	Elmenco	DM15-F-331J
C5	Mica, 220pF, ±5%, 100V	1002-0029	Elmenco	DM15-F-221J
	CLIPS			
	Sleeve, Guide	3768-0006	Elco	62-5204-4012
	Terminal, Printed Circuit	3768-0007	Elco	60-8200-0313
	CRYSTAL			
Y1	Crystal (Customer Request)		Cushman	
	DIODE			
CR1	Si, 1N3064	1281-0013	Sylvania	1N3064
	RESISTORS			
R1	Comp, 1kΩ, ±5%, 1/4W	1066-1025	Allen-Bradley	CB1025
R2	Comp, 47kΩ, ±5%, 1/4W	1066-4735	Allen-Bradley	CB4735
R3	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R4	Comp, 2.2kΩ, ±5%, 1/4W	1066-2225	Allen-Bradley	CB2225
R5	Comp, 3.3kΩ, ±5%, 1/4W	1066-3325	Allen-Bradley	CB3325
	TRANSISTOR			
Q1	Si, NPN, 2N3563	1272-0022	Fairchild	2N3563



1. FACTORY SELECT VALUE.



NOTE:

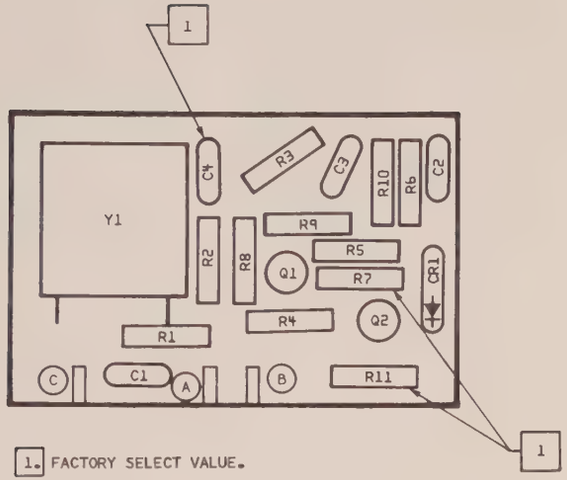
1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.
6. CUSTOMER REQUEST. (1.0 MHZ TO 13.5 MHZ).

5601-0015-2

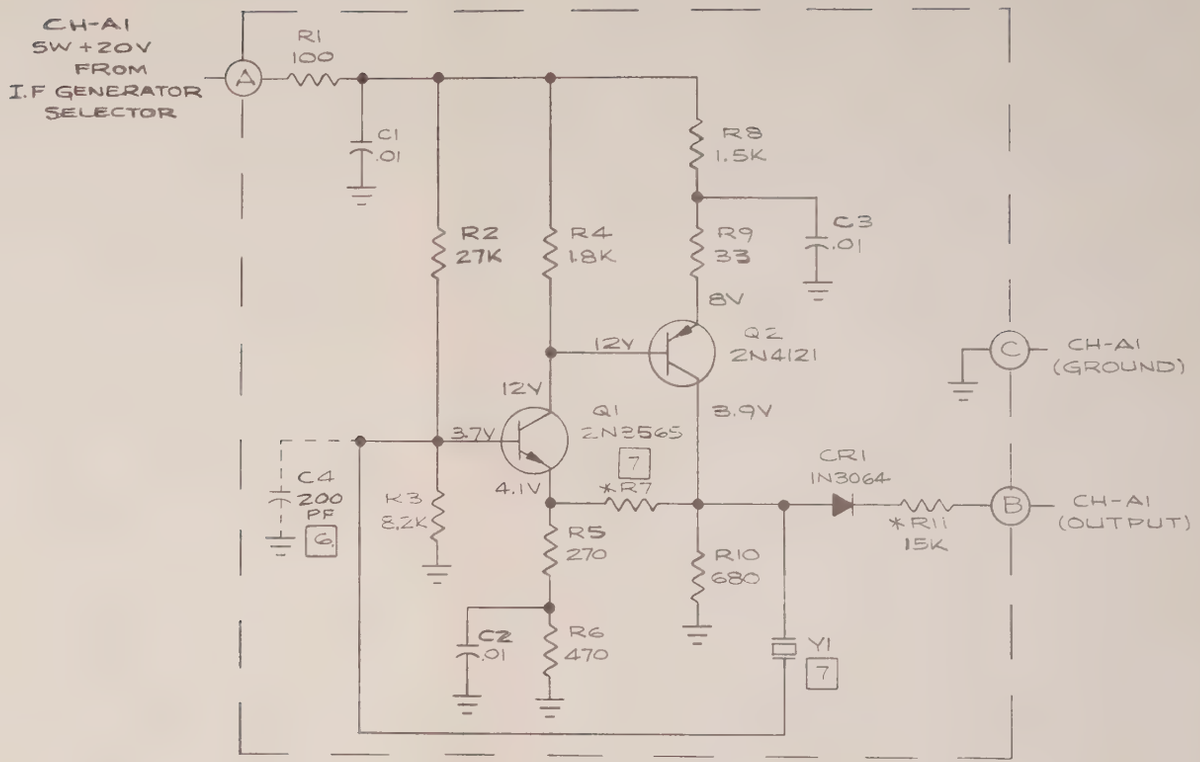
Figure 6-6. IF Oscillator, 1 MHz - 13.5 MHz. (CH-A6)

IF OSCILLATOR (CH-A7)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
CH-A7	Board Assembly, IF Oscillator	7001-0028	Cushman	
	Board, Printed Circuit	1780-0105	Cushman	
	CAPACITORS			
C1	Cer, 0.01μF, +80-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C2	Cer, 0.01μF, +80-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C3	Cer, 0.01μF, +80-20%, 25V	1005-0013	Erie	5835-512-Y5U-103Z
C4	Mica, 200 pF, ±5%, 100V	1002-0042	Elmenco	DM15-F-201J
	CLIPS			
	Sleeve, Guide	3768-0006	Elco	62-5204-4012
	Terminal, Printed Circuit	3768-0007	Elco	60-8200-0313
	CRYSTAL			
Y1	Crystal (Customer Request)		Cushman	
	DIODE			
CR1	Si, 1N3064	1281-0013	Transitron	1N3064
	RESISTORS			
R1	Comp, 100Ω, ±5%, 1/4W	1066-1015	Allen-Bradley	CB1015
R2	Comp, 27kΩ, ±5%, 1/4W	1066-2735	Allen-Bradley	CB2735
R3	Comp, 8.2kΩ, ±5%, 1/4W	1066-8225	Allen-Bradley	CB8225
R4	Comp, 1.8kΩ, ±5%, 1/4W	1066-1825	Allen-Bradley	CB1825
R5	Comp, 270Ω, ±5%, 1/4W	1066-2715	Allen-Bradley	CB2715
R6	Comp, 470Ω, ±5%, 1/4W	1066-4715	Allen-Bradley	CB4715
R7	Factory Select (Customer Request)			
R8	Comp, 1.5kΩ, ±5%, 1/4W	1066-1525	Allen-Bradley	CB1525
R9	Comp, 33Ω, ±5%, 1/4W	1066-3305	Allen-Bradley	CB3305
R10	Comp, 680Ω, ±5%, 1/4W	1066-6815	Allen-Bradley	CB6815
R11	Comp, 15kΩ, ±5%, 1/4W	1066-1535	Allen-Bradley	CB1535
	TRANSISTORS			
Q1	Si, NPN, 2N3565	1272-0017	Fairchild	2N3565
Q2	Si, PNP, 2N4121	1272-0023	Fairchild	2N4121



1. FACTORY SELECT VALUE.



NOTE:

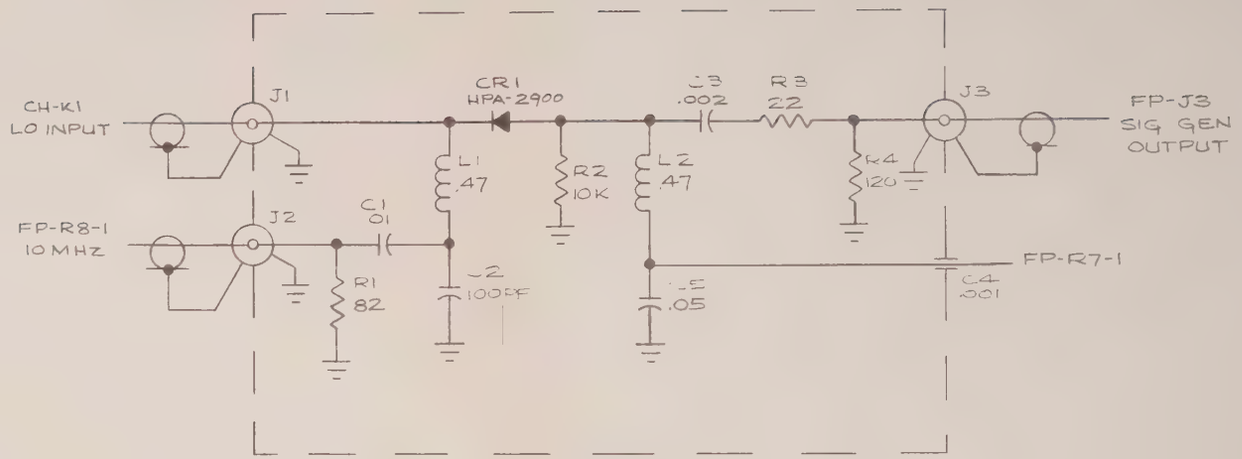
1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

6. C4, 200 PF IS ADDED WHEN 250 KHZ OR 290 KHZ CRYSTAL IS USED.

Figure 6-7. IF Oscillator, 250 kHz - 900 kHz. (CH-A7)

SIGNAL GENERATOR MIXER (CH-A3)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
CH-A3	Assembly, Signal Generator Mixer	7040-0020	Cushman	
	CAPACITORS			
C1	Cer, 0.01μF +80-20%, 75V	1005-0013	Erie	5835-512-Y5U-103Z
C2	Cer, Stand Off, 100pF, GMV, 500V	1005-0049	Eire	2425-061-X5U0-101AA
C3	Cer, 0.002μF, ±20%, 600V	1005-0003	Erie	831-596-Z5U-202M
C4	Cer, Feedthru, 0.001μF, ±20%, 500V	1005-0008	Erie	357-001-X5U0-102M
C5	Cer, 0.05μF +80-20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
	COILS			
L1	Choke, RF, 0.47μH, ±20%	1585-0031	Delevan	1537-06
L2	Choke, EF, 0.47μH, ±20%	1585-0031	Delevan	1537-06
	CONNECTORS			
J1	Connector, BNC	2536-0006	Startronics	UG-1098/U
J2	Connector, BNC	2536-0006	Startronics	UG-1098/U
J3	Connector, BNC	2536-0010	King	KC79-35
	DIODE			
CR1	Si, HPA2900	1283-0003	HPA	5082-2900
	RESISTORS			
R1	Comp, 82Ω, ±5%, 1/4W	1066-8205	Allen-Bradley	CB8205
R2	Comp, 10kΩ, ±5%, 1/4W	1066-1035	Allen-Bradley	CB1035
R3	Comp, 22Ω, ±5%, 1/4W	1066-2205	Allen-Bradley	CB2205
R4	Comp, 120Ω, ±5%, 1/4W	1066-1215	Allen-Bradley	CB1215



NOTE:

1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

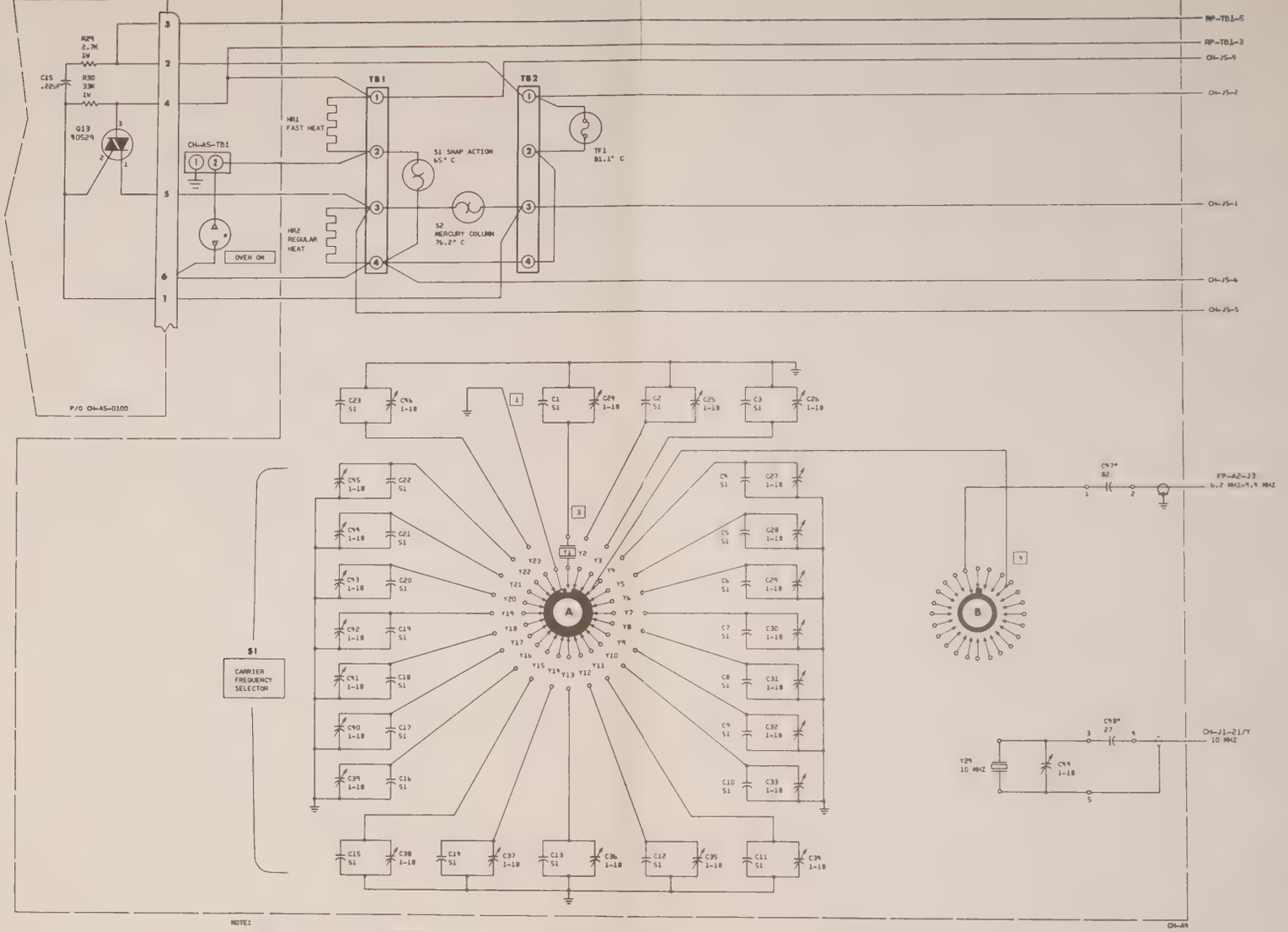
Figure 6-8. Signal Generator Mixer. (CH-A3)

CRYSTAL OVEN ASSEMBLY (CH-A4)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
CH-A4	Assembly, Crystal Oven	7046-0007	Cushman	
	Assembly, Oven Body	7046-0006	Cushman	
	Assembly, Crystal Base	7040-0002	Cushman	
	Assembly, 10-MHz Crystal Bracket	7040-0003	Cushman	
	Assembly, Oven Cover	7005-0007	Cushman	
	CAPACITORS			
C1	Mica, 51pF, ±1%, 100V	1002-0056	Elmenco	DM15-E-510F
C2	Mica, 51pF, ±1%, 100V	1002-0056	Elmenco	DM15-E-510F
C3	Mica, 51pF, ±1%, 100V	1002-0056	Elmenco	DM15-E-510F
C4	Mica, 51pF, ±1%, 100V	1002-0056	Elmenco	DM15-E-510F
C5	Mica, 51pF, ±1%, 100V	1002-0056	Elmenco	DM15-E-510F
C6	Mica, 51pF, ±1%, 100V	1002-0056	Elmenco	DM15-E-510F
C7	Mica, 51pF, ±1%, 100V	1002-0056	Elmenco	DM15-E-510F
C8	Mica, 51pF, ±1%, 100V	1002-0056	Elmenco	DM15-E-510F
C9	Mica, 51pF, ±1%, 100V	1002-0056	Elmenco	DM15-E-510F
C10	Mica, 51pF, ±1%, 100V	1002-0056	Elmenco	DM15-E-510F
C11	Mica, 51pF, ±1%, 100V	1002-0056	Elmenco	DM15-E-510F
C12	Mica, 51pF, ±1%, 100V	1002-0056	Elmenco	DM15-E-510F
C13	Mica, 51pF, ±1%, 100V	1002-0056	Elmenco	DM15-E-510F
C14	Mica, 51pF, ±1%, 100V	1002-0056	Elmenco	DM15-E-510F
C15	Mica, 51pF, ±1%, 100V	1002-0056	Elmenco	DM15-E-510F
C16	Mica, 51pF, ±1%, 100V	1002-0056	Elmenco	DM15-E-510F
C17	Mica, 51pF, ±1%, 100V	1002-0056	Elmenco	DM15-E-510F
C18	Mica, 51pF, ±1%, 100V	1002-0056	Elmenco	DM15-E-510F
C19	Mica, 51pF, ±1%, 100V	1002-0056	Elmenco	DM15-E-510F
C20	Mica, 51pF, ±1%, 100V	1002-0056	Elmenco	DM15-E-510F
C21	Mica, 51pF, ±1%, 100V	1002-0056	Elmenco	DM15-E-510F
C22	Mica, 51pF, ±1%, 100V	1002-0056	Elmenco	DM15-E-510F
C23	Mica, 51pF, ±1%, 100V	1002-0056	Elmenco	DM15-E-510F
C24	Var, glass, .5-18pF	1001-0001	J. F. D.	VCJ2611
C25	Var, glass, .5-18pF	1001-0001	J. F. D.	VCJ2611
C26	Var, glass, .5-18pF	1001-0001	J. F. D.	VCJ2611
C27	Var, glass, .5-18pF	1001-0001	J. F. D.	VCJ2611
C28	Var, glass, .5-18pF	1001-0001	J. F. D.	VCJ2611
C29	Var, glass, .5-18pF	1001-0001	J. F. D.	VCJ2611
C30	Var, glass, .5-18pF	1001-0001	J. F. D.	VCJ2611
C31	Var, glass, .5-18pF	1001-0001	J. F. D	VCJ2611
C32	Var, glass, .5-18pF	1001-0001	J. F. D.	VCJ2611
C33	Var, glass, .5-18pF	1001-0001	J. F. D.	VCJ2611
C34	Var, glass, .5-18pF	1001-0001	J. F. D.	VCJ2611
C35	Var, glass, .5-18pF	1001-0001	J. F. D.	VCJ2611
C36	Var, glass, .5-18pF	1001-0001	J. F. D.	VCJ2611
C37	Var, glass, .5-18pF	1001-0001	J. F. D.	VCJ2611
C38	Var, glass, .5-18pF	1001-0001	J. F. D.	VCJ2611
C39	Var, glass, .5-18pF	1001-0001	J. F. D.	VCJ2611
C40	Var, glass, .5-18pF	1001-0001	J. F. D.	VCJ2611
C41	Var, glass, .5-18pF	1001-0001	J. F. D.	VCJ2611
C42	Var, glass, .5-18pF	1001-0001	J. F. D.	VCJ2611
C43	Var, glass, .5-18pF	1001-0001	J. F. D.	VCJ2611
C44	Var, glass, .5-18pF	1001-0001	J. F. D.	VCJ2611
C45	Var, glass, .5-18pF	1001-0001	J. F. D.	VCJ2611
C46	Var, glass, .5-18pF	1001-0001	J. F. D.	VCJ2611
C47	Mica, 82pF, ±2%, 500V	1002-0003	Elmenco	DM15-E-820G
C48	Mica, 27pF, ±5%, 100V	1002-0008	Elmenco	DM15-E-270J
C49	Var, glass, .5-18pF	1001-0001	J. F. D.	VCJ2611

CRYSTAL OVEN ASSEMBLY (CH-A4) (cont.)

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
	CRYSTALS			
Y1 through Y23	Crystal, (Customer Request)		Cushman	
Y24	Crystal, 10-MHz	2035-0005	Cushman	
	FUSE			
TF1	Thermal	1955-0010	Micro Devices	4178
	INSULATION			
	Oven Body	4971-0010	Durvon	D4971-0010
	SWITCH			
S1	Rotary, 24 pos.	1851-0028	Cushman	
	THERMOSTATS			
S1	Switch, #32410-0	1345-0002	Fenwal	32410-0
S2	Sub-Min. Bi-Metal	1345-0005	Cushman	



NOTE:

1. CAPACITORS – VALUES IN PF UNLESS OTHERWISE NOTED.
2. *FACTORY SELECT. TYPICAL VALUE SHOWN.
3. Y1 THROUGH Y23 PLUG-IN CRYSTALS. (CUSTOMER REQUEST)
4. ALL POSITIONS S1A INTERCONNECT S1B EXCEPT PIN 29 AS SHOWN.

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Figure 6-9. Crystal Oven Assembly. (CH-A4)

MAIN CHASSIS

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
CH	Assembly, Main Chassis	7000-0002	Cushman	
	Assembly, Right Angle Drive	7040-0027	Cushman	
	Assembly, Handle	4230-0004	Phila Handle Co.	
	CAPACITORS			
C1	Cer, 0.05μH, +80-20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C2	Cer, 0.05μH, +80-20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C3	Cer, 0.05μH, +80-20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C4	Cer, 0.05μH, +80-20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
	CONNECTORS			
J1	Female, 44 pin	2535-0023	Viking	2VK22D/1-1
J2	Female, 22 pin	2535-0018	Viking	2VK22S/1-1
J3	Female, 24 pin	2535-0020	Amphenol	25-190-24
J4	Not Used			
J5	Female, 22 pin	2535-0018	Viking	2VK22S/1-1
J6	Female, 24 pin	2535-0020	Amphenol	25-190-24
J7	Connector, BNC,	2536-0031	Specialty Co	28JS140-2
	DIODE			
CR1	Si, 1N4002	1281-0023	Sylvania	1N4002
	RELAY			
K1	Coaxial, 50Ω, 250W, 28V	1313-0010	Magnecraft	120X-122
	SPEAKER			
LS1	3 in. x 5 in. Speaker	1715-0003	Quam	74-6248
	TRANSISTORS			
Q1	Si, NPN, 2N3054	1271-0001	RCA	2N3054
Q2	Si, NPN, 2N3054	1271-0001	RCA	2N3054

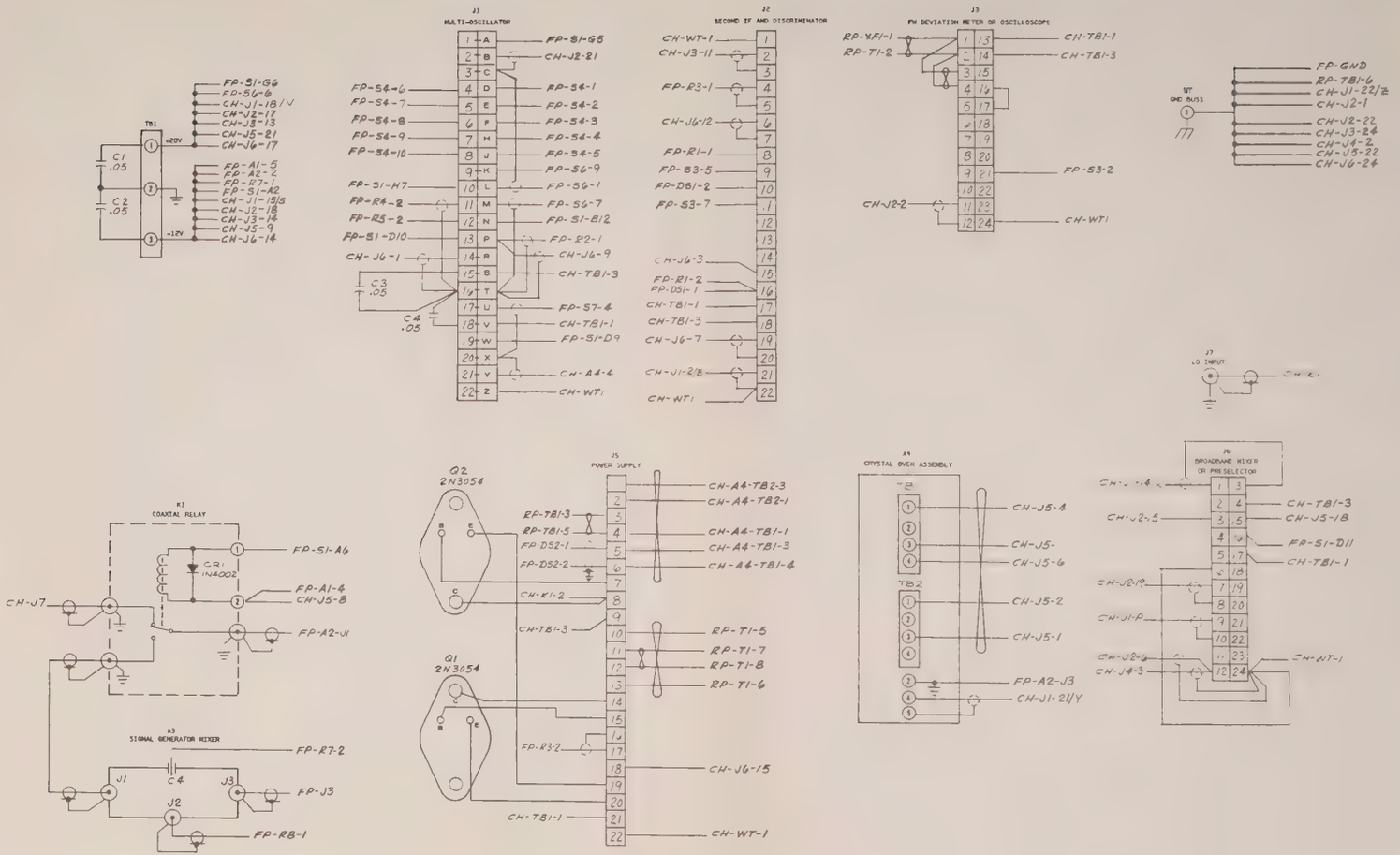

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Figure 6-10. Main Chassis, Wiring Diagram.

FRONT PANEL

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
FP	Assembly, Front Panel	7003-0003	Cushman	
	BEZEL			
	Front	4560-0005	Cushman	
	CAPACITORS			
C1	Cer, 0.002μF, ±20%, 600V	1005-0003	Erie	831-596-Z5U-202M
C2	Cer, 0.1μF, +80-20%, 75V	1005-0019	Centralab	DDA104
C3	Cer, 0.05μF, +80-20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
C4	Cer, 0.05μF, +80-20%, 25V	1005-0014	Erie	5855-505-Y5U0-503Z
	CONNECTORS			
J1	BNC, Female, UG-1094/U	2536-0010	King	KC79-35
J2	BNC, Female, UG-1094/U	2536-0010	King	KC79-35
J3	BNC, Female, UG-1094/U	2536-0010	King	KC79-35
J4	BNC, Female, UG-1094/U	2536-0010	King	KC79-35
	LAMPS			
DS1	Incandescent, cartridge, 10V, 14MA	2870-0010	Dialco	507-3910-1431-600
DS2	Neon, cartridge	2900-0007	Dialco	507-4537-1437-640
	METER			
M1	Frequency Error Meter	1402-0019	Cushman	
	PANEL			
	Front	2800-0031	Cushman	
	RESISTORS			
R1	Pot, comp, lin, 100Ω, 2W	p/o1851-0040	CTS	
R2	Pot, comp, lin, 250Ω, 2W	1203-0019	Allen-Bradley	JA4N048P251UA
R3	Pot, comp, lin, 10kΩ, 2W	p/o1203-0018	Allen-Bradley	JS4N048P103UA
R4	Pot, comp, log, 1kΩ, 2W	p/o1204-0003	Allen-Bradley	JVC91400C
R5	Pot, comp, lin, 0.5MΩ, 2W	p/o1204-0003		
R6	Comp, 470kΩ, ±5%, 1/4W	1066-4745	Allen-Bradley	CB4745
R7	Pot, 10 turn, 10kΩ	1203-0029	Amphenol	4101N103
R8	Pot, comp, lin, 3kΩ, 2W	p/o1204-0004	Allen-Bradley	JJ9204A
R9	Pot, comp, lin, 50Ω, 2W	p/o1204-0004		
R10	M Film, 54.9Ω, ±1%, 1/10W	1075-0005	Electra	
R11	M Film, 61.9Ω, ±1%, 1/10W	1075-0007	Dale	MF 1/10 T1
R12	M Film, 499Ω, ±1%, 1/10W	1075-0008	Dale	MF 1/10 T1
R13	M Film, 499Ω, ±1%, 1/10W	1075-0008	Dale	MF 1/10 T1
	SWITCHES			
S1	Rotary, special	p/o1851-0040	Cushman	
S2	Lever, 2P3 pos, range	1851-0016	Cushman	
S3	Rotary, 4P2 pos.	1851-0022	Centralab	PA1010
S4	Rotary, 1P10 pos.	1851-0030	Cushman	
S5	2P2 pos. with pot, power off, vol. control	p/o1203-0018		
S6	Toggle 3P2 pos	1850-0007	Alco	MST-3050
S7	Rotary, 1P3 pos.	1851-0049	Cushman	

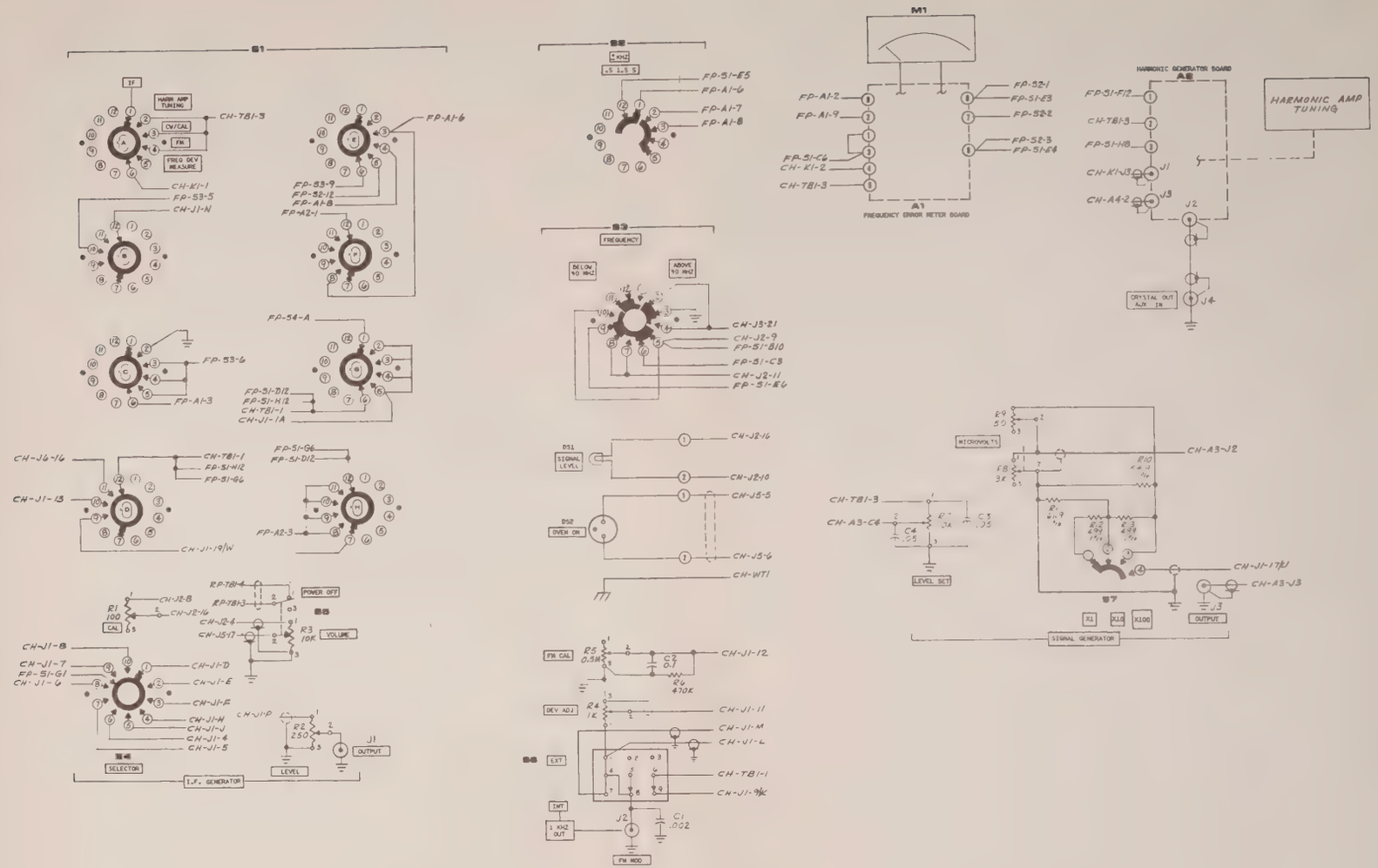

Figure 6-11. Front Panel, Wiring Diagram.

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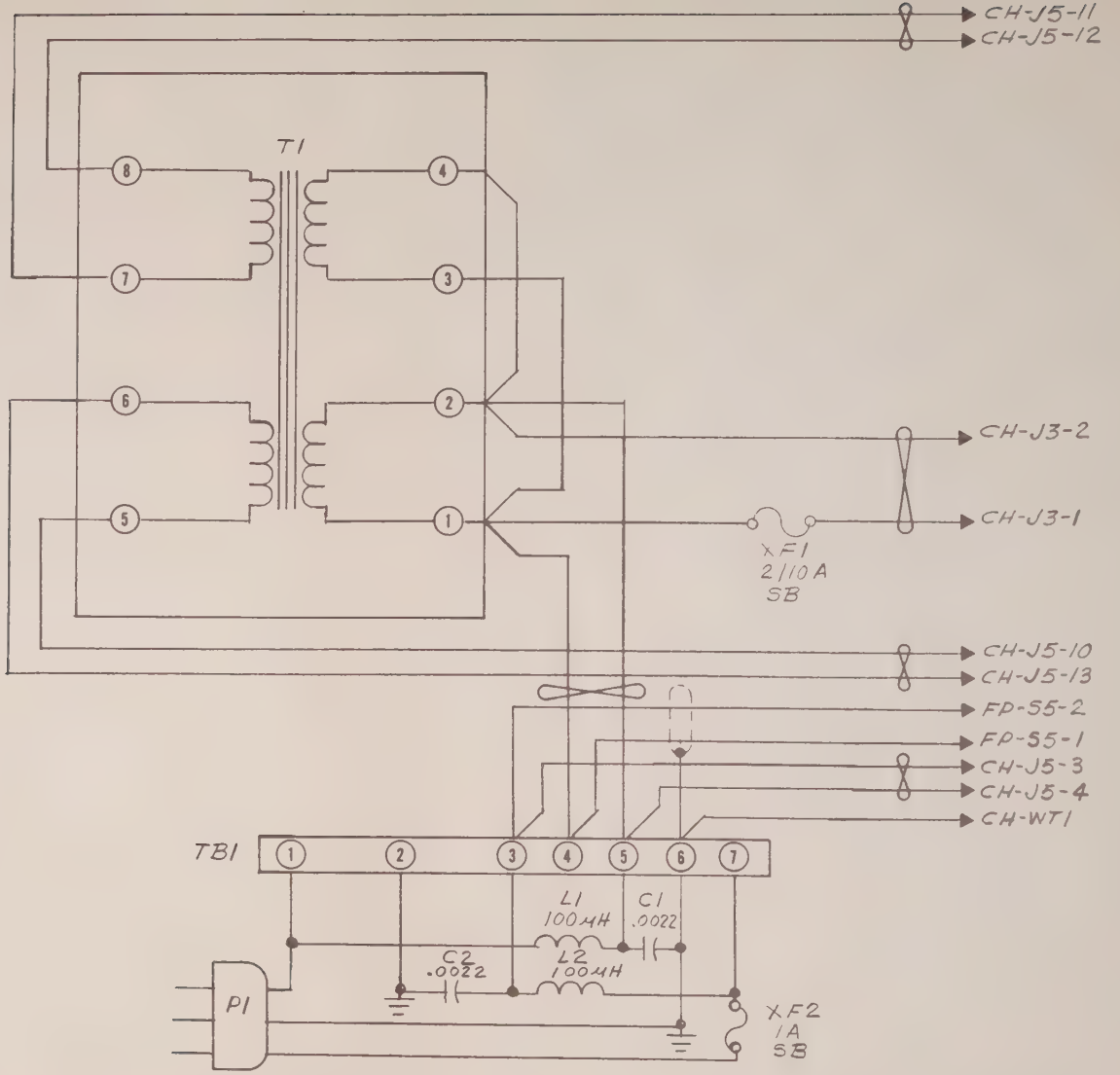
REAR PANEL

CKT. REF.	DESCRIPTION	CE STOCK NO.	MFR.	MFR. NO.
RP	Assembly, Rear Panel	7001-0012	Cushman	
	BEZEL			
	Rear	4560-0005	Cushman	
	CAPACITORS			
C1	Cer, 2200pF, ±20%, 3KV	1005-0098	Erie	818Y5
C2	Cer, 2200pF, ±20%, 3KV	1005-0098	Erie	818Y5
	COILS			
L1	Choke, RF, 100μH, ±10%, 600V	1585-0040	Miller	B-6021
L2	Choke, RF, 100μH, ±10%, 600V	1585-0040	Miller	B-6021
	FUSES			
F1	3AG MDL, 2/10 amp, slo-blo	1955-0009	Bussman	MDL2/10
F2	3AG, 1 amp, slo-blo	1955-0006	Littelfuse	3AG-313001
	FUSEHOLDERS			
X1	Fuseholder	1965-0004	Littelfuse	341001AL
X2	Fuseholder	1965-0004	Littelfuse	341001AL
	PANEL			
	Rear	2800-0032	Cushman	
	PLUG			
P1	Molded, 3 wire, 18 gauge	3170-0001	Belden	17409B
	TRANSFORMER			
T1	Transformer, Power	1575-0008	Cushman	



NOTE:

1. RESISTORS - 1/4W, 5% VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITORS - VALUES IN μF UNLESS OTHERWISE NOTED.
3. INDUCTORS - VALUES IN μH UNLESS OTHERWISE NOTED.
4. *FACTORY SELECT. TYPICAL VALUE SHOWN.
5. ALL VOLTAGES ARE DC UNLESS OTHERWISE NOTED.

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Figure 6-12. Rear Panel, Wiring Diagram.

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